LEMBAGA ILMU PENGETAHUAN INDONESIA
*(INDONESIAN INSTITUTE OF SCIENCES)*

LIPI

# Biodiversity and Genetic Resources: Role in ASEAN's Sustainable Development


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ASEAN - JAPAN Collaboration on Bioeconomy and Circular Economy, 19 November 2020

# OUTLINE

I. INTRODUCTION: STATUS OF BIORESOURCES AND GENETIC RESOURCES

II. BIORESOURCES FOR SUSTAINABLE DEVELOPMENT IN ASEAN: OPPORTUNITIES

III. RESEARCH-BASED BIOECONOMY: Collaboration Indonesia – Japan case

IV. STRATEGY TO BOOST BIOECONOMY IN ASEAN

V. WAY FORWARD AND CONCLUSIONS

# INTRODUCTION: GENETIC RESOURCES

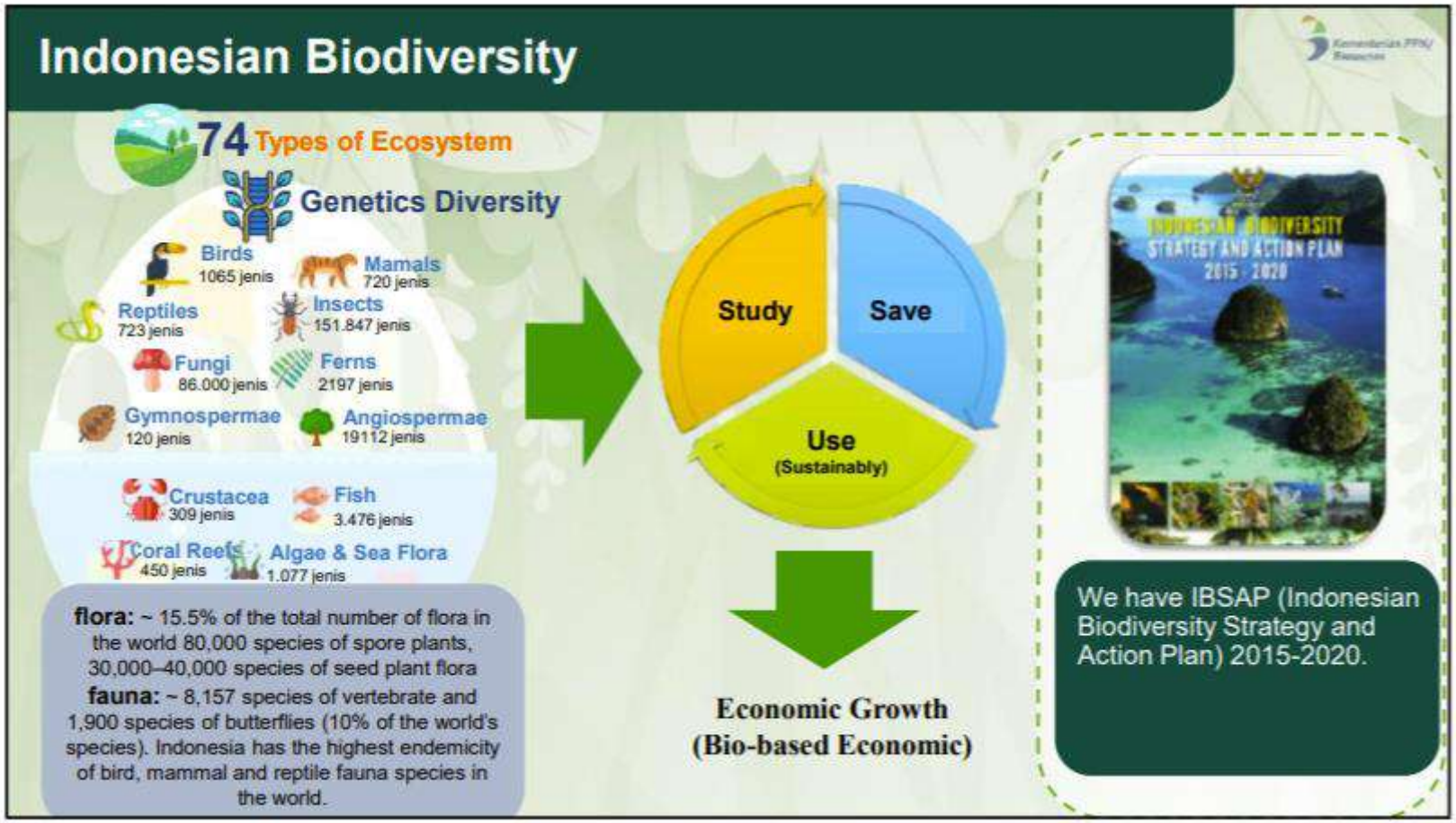
- ASEAN region is biologically rich, with over 20% of all known species of plants, animals and marine organisms in the region: 1) **Indonesia as the richest in the world combining the terrestrial and marine resources). It harbors 10% of all flowering plants and harbors 1 of the largest collections of indigenous medicinal plants in the world, 2nd to the Amazonia. 2) Thailand claims as a biodiversity hotspot ranked as the eighth most bio-diverse region in the world, estimated to support about 10% of all species of living organisms in the world** → ASEAN natural resources richness and abundance biomass → could be a strong economy in the world if focusing on bio-based industries
- FACT: most are still highly dependent on non processed natural resources → opportunity for the biodiversity-based economy to become a major economic driver if managed in a sustainable way.

| Country | Areas of Closed Forest (hectares) |
|---|---|
| Brazil | 357,480,000 |
| Indonesia | 113,895,000 |
| Zaire | 105,750,000 |
| Peru | 69,680,000 |
| India | 51,841,000 |
| Colombia | 46,400,000 |
| Mexico | 46,250,000 |
| Bolivia | 44,010,000 |
| Papua New Guinea | 34,230,000 |
| Burma | 31,941,000 |
| Venezuela | 31,870,000 |
| Congo | 21,340,000 |
| Malaysia | 20,995,000 |
| Gabon | 20,500,000 |
| Guyana | 18,475,000 |
| Cameroon | 17,920,000 |
| Suriname | 14,830,000 |
| Ecuador | 14,250,000 |
| Madagascar | 10,300,000 |

[a]From OTA, 1984, and Mittermeier and Oates, 1985.

# INTRODUCTION: GENETIC RESOURCES

- INDONESIA



# Number of Fauna species in Indonesia

(source: Book: Updated Biodoversity Status, 2015)

| Species Diversity | World | Indonesia | Percentage |
|---|---|---|---|
| Birds | 10.140 | 1.605 | 16 % |
| Reptile | 9.084 | 723 | 8 % |
| Amphibian | 6.433 | 385 | 5.99 % |
| Lizard (Varanus) | 50 | 21 | 40 % |
| Fresh water fish | 14.000 | 1.248 | 8.91 % |
| Mammals | 5.416 | 720 | 13 % |
| Mollusc | 194.552 | 5.170 | 2.65 % |
| - Gastropoda | 181.525 | 4.000 | 2.20 % |
| - Bivalvia | 9.947 | 4.000 | 40.2 % |
| - Scaphopoda | | 70 | |
| - Cephalopoda | 952 | 100 | 10.5 % |
| Nematode | ? | 90 | |
| Arthropode | | | |
| 1. Crustaceae | 66.900 | 1.200 | 10 % |
| - Fresh water prawn | | 122 | |
| 2.Fresh water crab | | 120 | |
| 3. Mangrove crab | | 99 | |
| 4. Spider (Arachnida) | 57.228 | 2.096 | 3.66 % |
| 5. Collembola | 6.000 | 1.500 (300 unidentified) | |
| 6. Insects | 10.000.000 | 151.847 | 15 % |
| - Butterfly | 17.700 | 1.900 | 10.69 % |
| - Moth | 123.738 | 12.000 | 10 % |
| - Beetle | 260.706 | 21.758 | 8.34 % |
| - Dragonfly | 5.900 | 1.500 | 25.42 % |
| Hymenopterae | 150.000 | 30.000 | 20 % |
| - Fly (Diptera) | 144.377 | 27.694 | 29.18 % |
| - Honey bee (Apidae) | 7 | 6 | 85.7 % |
| - Ants (Formicidae) | 11.000 | 1863 | 16.94 % |
| - Bee (Vespidae) | 5.000 | 541 | 18.82 % |
| Orthopterae | 20.000 | 2.000 | 10 % |

# Biodiversity: types and richness in various islands of Indonesia

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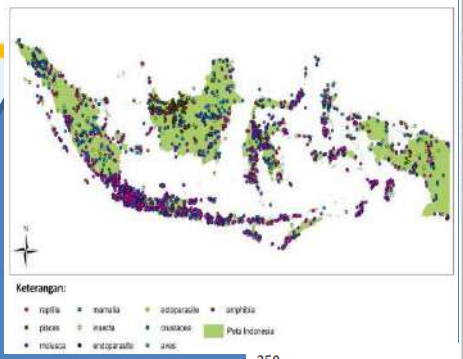
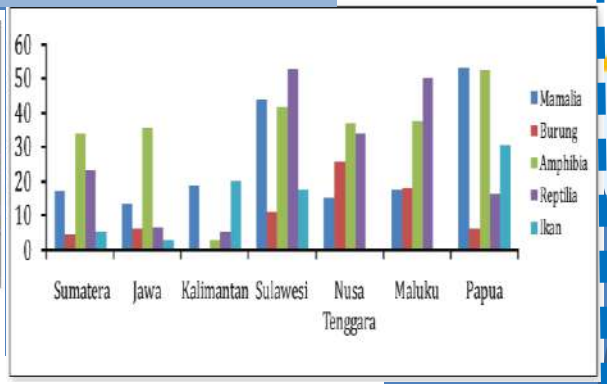
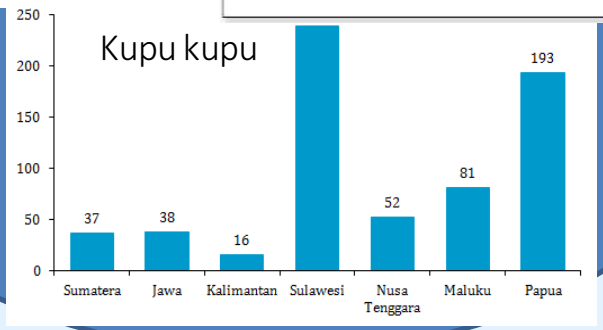
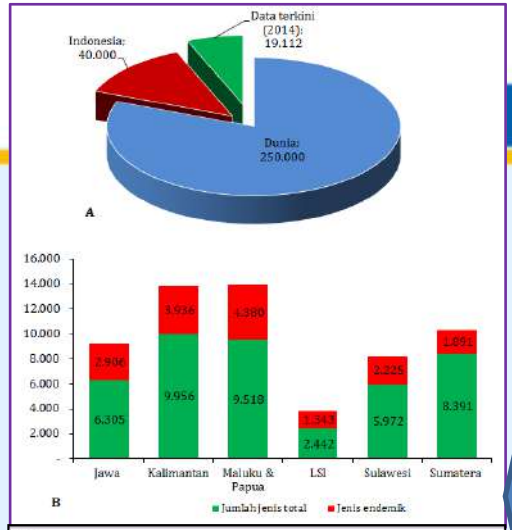
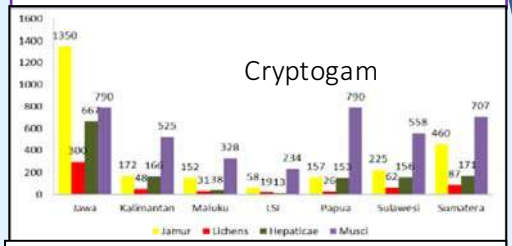
## FAUNA

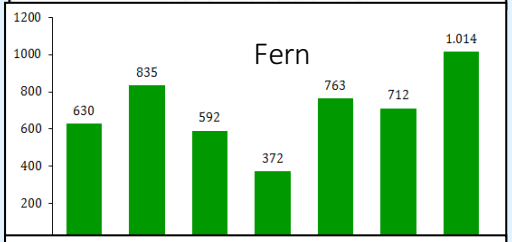


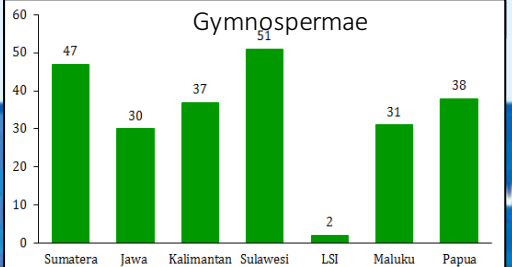




FLORA

Each island has its own characteristic or uniqueness (ecosystem – genetic levels)

As a development modality

**(Widjaya, et.al., 2015)**

# STATUS OF INDONESIA'S FLORA

(A. Retnowati, et. al. 2019)

| Flora | World (estimated) | Indonesia (identified up to 2017) | Percentage of identified |
|---|---|---|---|
| **Seedless plants** | | | |
| 1. Cryptogam | | | |
| - Fungi | 1.500.000 | 2.273 | 0.15 % |
| - Lichen | 20.000 | 595 | 2.98 % |
| - Hepaticae | 7.500 | 849 | 11.32 % |
| - Musci | 12.800 | 1.845 | 14.41 % |
| 2. Fern | 10.000 | 2.197 | 21.97 % |
| **Spermatophyte** | | | |
| 1. Gympospermae | 1.000 | 120 | 12 % |
| 2 Angiospermae | 250.000 | 19.112 identified out of 30.000-40.000 recorded | 50 % |

**Flora:**

**Target of Site Exploration:**

* Eastern part of Indonesia (Sumba, Lombok, Sorong, Asmat, Flores).
* Small and Outer Islands (Tanimbar, Wetar, Enggano, etc.)
* Ecotourism Sites of National Priority: such as Mandalika (Lombok Island, Borobudur, Toba Lake).

**Targeted population study: Flora and Fauna**;

- In the Trading List of CITES
- Endemic
- Potency for medicine and other uses
- Database status
- Biodiversity Loss analysis

**2018: 24.632 plant species (A. Retnowati, et. al. 2019)**

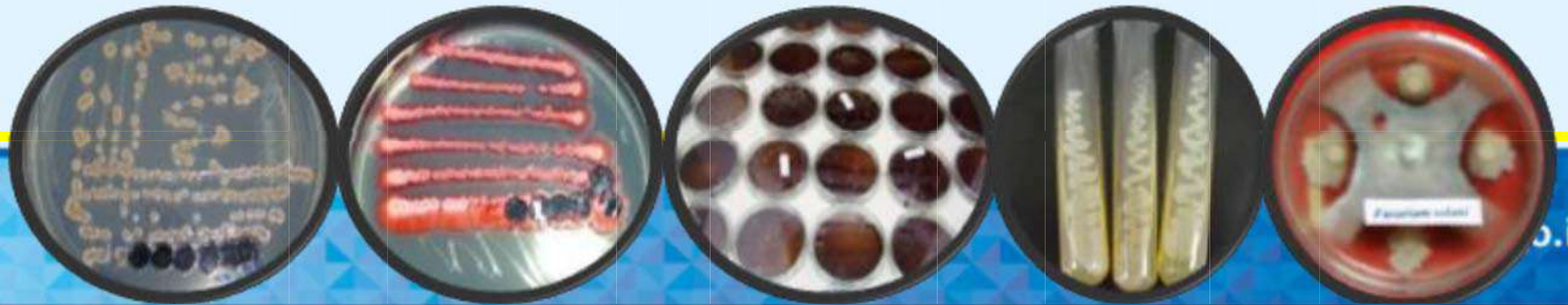
**Types and Sites of microorganism exploration in Indonesia (InaCC, 2018):**
**51 new species found by LIPI → still a lot more to do !!!**


**Data collected from 7 culture collection in Indonesia: 24 provinces out of 34**

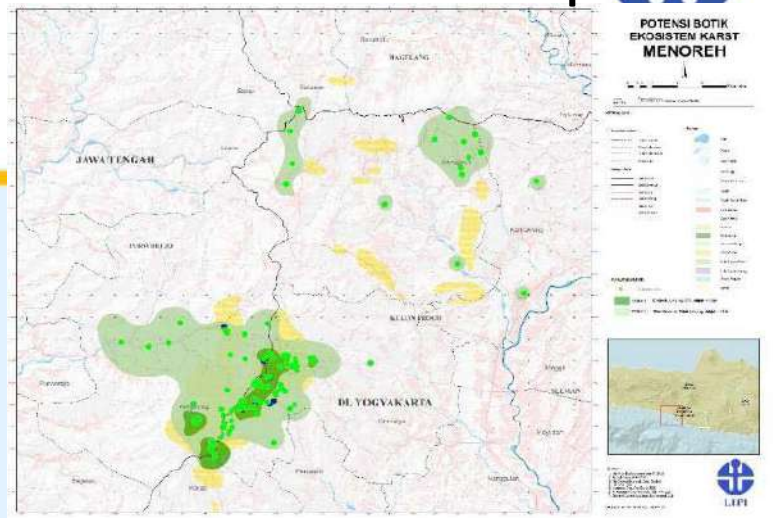
# Superior Microbes selected from LIPI's micobes collections

(source: RC Biotechnology LIPI)

- **Produce growth regulators**: ***Bacillus, Pseudomonas, Stenotrophomonas***
- **Phospor Solvent**: ***Streptomyces, Bacillus, V A mycorrhiza***
- **N fixing**: ***Rhizobium, Azospirillum, Azotobacter***
- **Biocontrol**: ***Bacillus, Chrysobacterium, Trichoderma, Fusarium***
- **Organic degrading**: ***Trichoderma, Aspergillus***
- **Pesticide degrading** : ***Rhodoccus, Pseudomonas***
- ***Antibiotic, vaccines, etc.***



# Bioresources Map




Approx. only **1,78 millions out of 5-30 millions (6%) species in the world have been described → the rest: home work !!!**

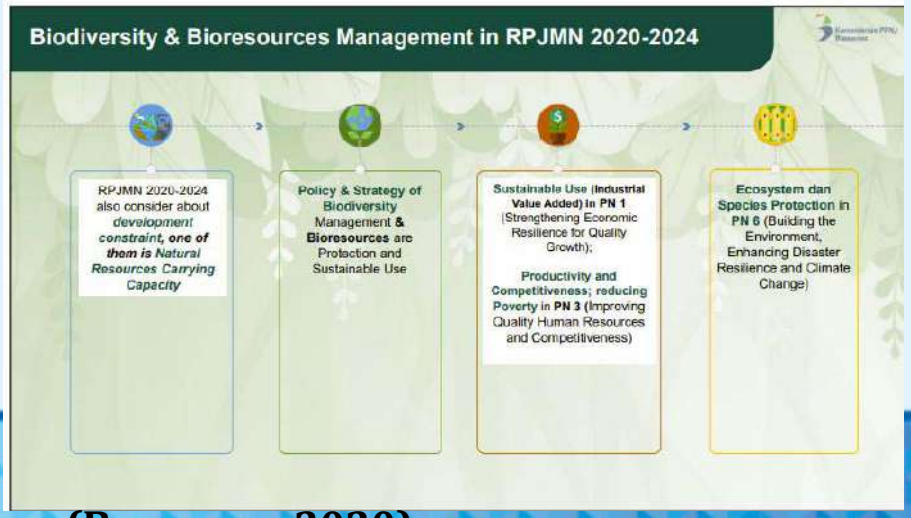
Bioresources map achieved still **70%**, end 2019: 10 bioresources map completed, which was end of Strategic Plan 2015-2019

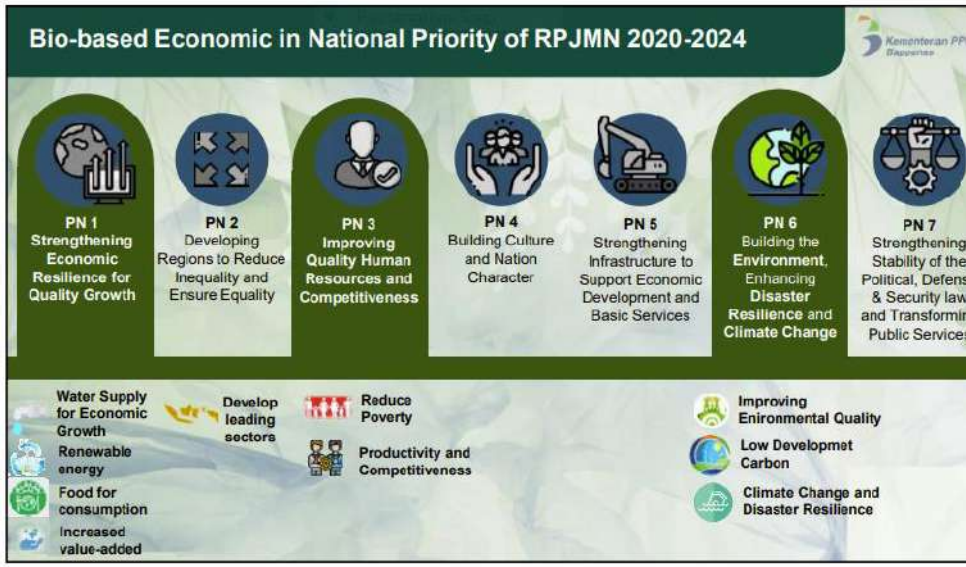
# ECONOMY & BIOECONOMY OF ASEAN

- In Asia, Malaysia is the 2nd country (after China) to have a dedicated bioeconomy roadmap: officially launched in 2012, followed by the establishment of the Bioeconomy Transformation Programme (BTP): greater focus on research and innovation to replace or to reduce the dependency on conventional **fossil materials**.
- Thailand's food industry contributed approximately 23% of the country's GDP. Significant investment has been made to support biodiversity research and establish world-class infrastructure for preserving microorganisms with the purpose of utilization study, making the country No. 6 in the world in term of microbial collection.
- Indonesia does not have a specific one bioeconomy programme and strategy but bioeconomy in National Development is reflected in several National Priority Progammes and stated in RPJMN, and promoted at a political level by the "National Energy Policy" and the "Grand Strategy of Agricultural Development 2015-2045", especially in two areas, bioenergy and agroindustry. For palm oil production, the government has set standards for sustainability.
- Indonesia: Agriculture, Forestry and Fisheries sectors contributed 13.4% of the GDP in Q2-2018 → should be able to boost bioeconomy which approach and model developed are different from other countries → due to its natural potential and the characteristics of its population.

# BIOECONOMY IN INDONESIA

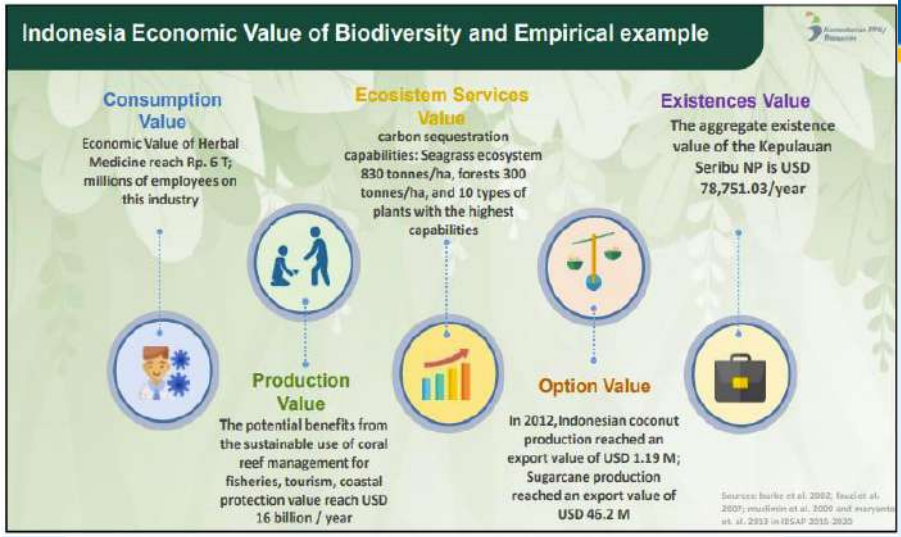





(Bappenas, 2020)

# BIOECONOMY IN INDONESIA



(Bappenas, 2020)

We need more efforts for biodiversity conservation and sustainable bioprospection and bioeconomy. Public awareness and cooperation from every aspect of stakeholder is necessary. Nevertheless, mainstreaming in biodiversity become important.

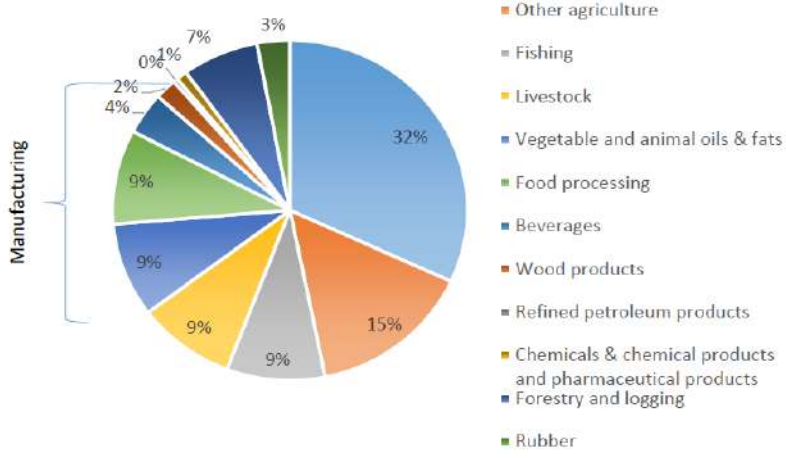
(Minister of Research and Technology , 2020)

# BIOECONOMY: Malaysia, Indonesia

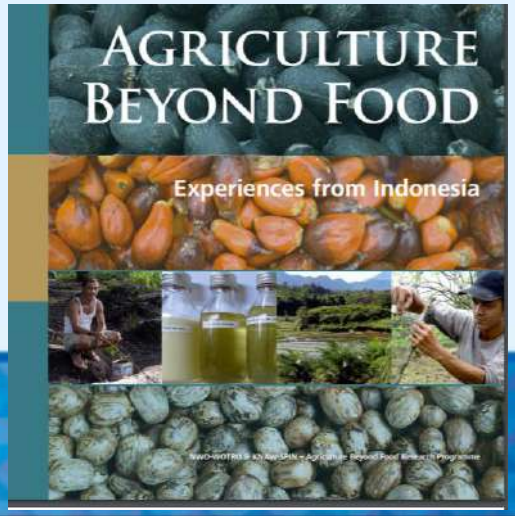
- Malaysia: assessed bioeconomy: 2012: Bioeconomy Transformation Programme (BTP) and 2014: Bioeconomy Community Development Programme (BCDP) → Bioeconomy Corporation
- Indonesia assessments on Bioeconomy


**Source:** Bioeconomy Corp and MOSTI (2018).

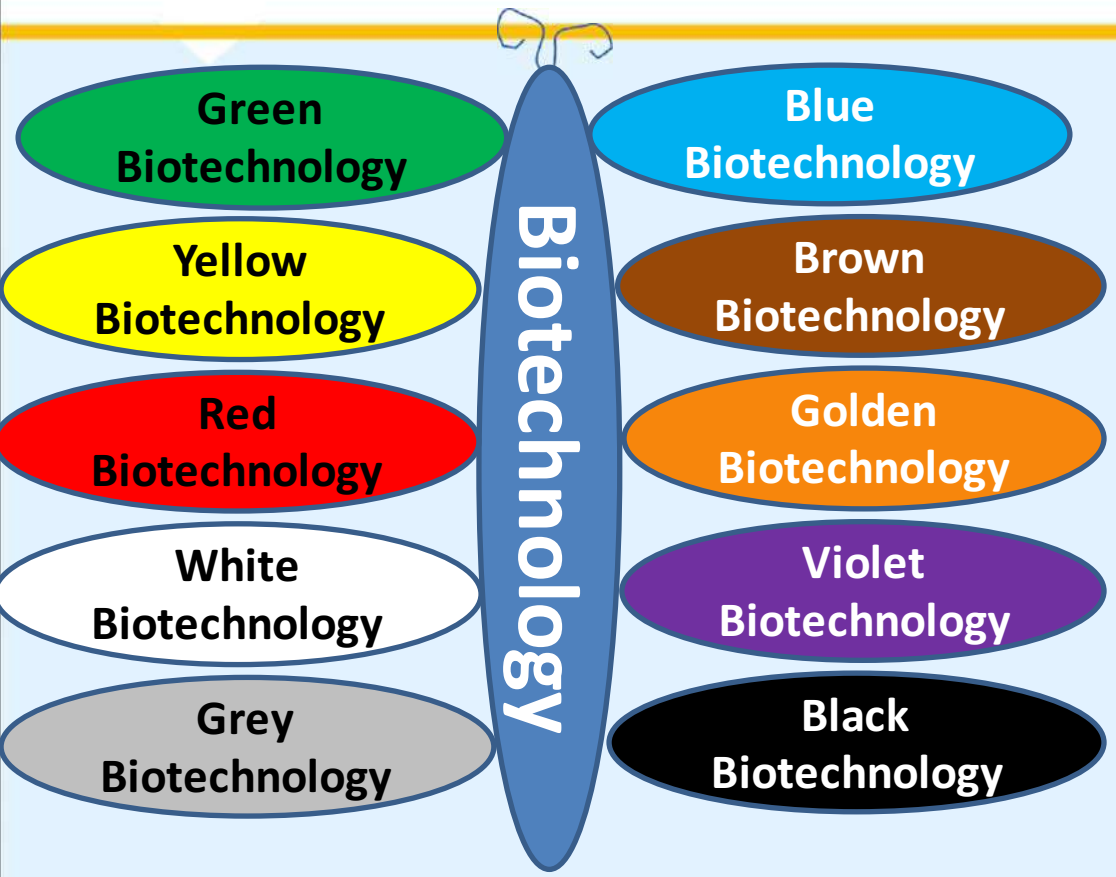
**Figure 7. Breakdown of bioeconomy contribution to GDP by subsectors in 2014, by value.**

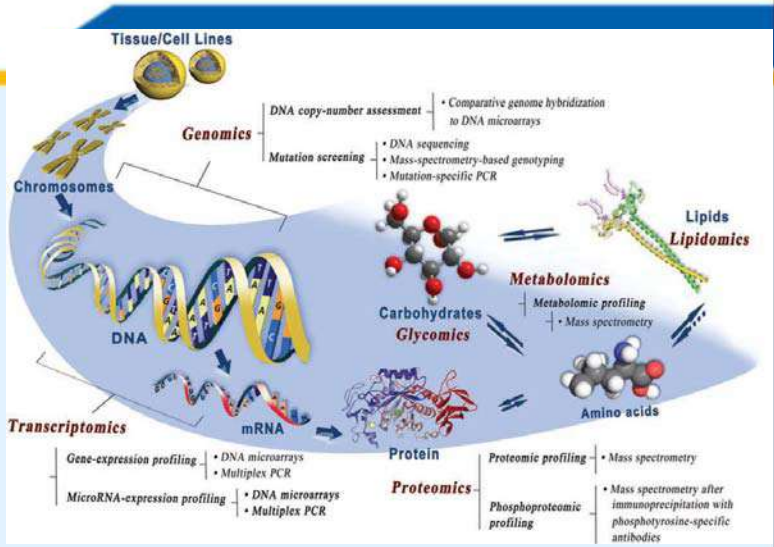


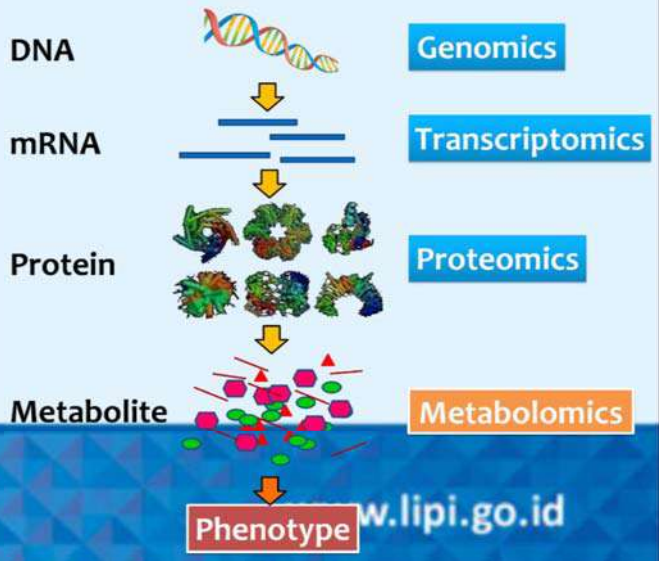

**Source:** Fadillah (2015).

# Biotechnology Scope of Research

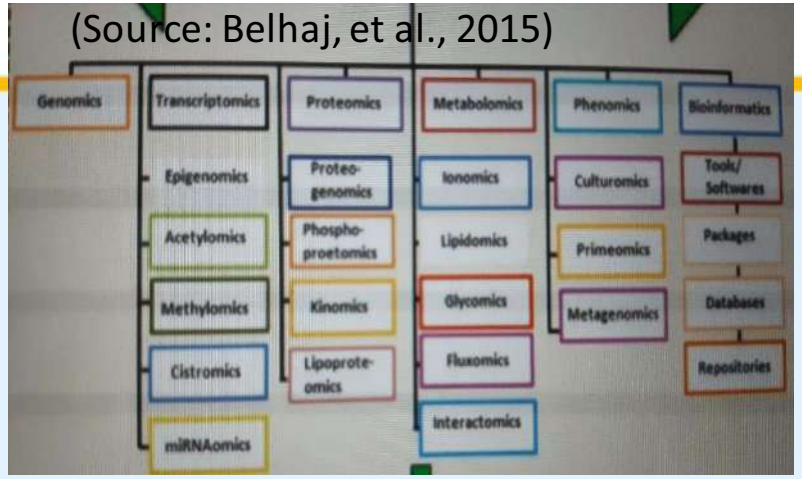


# OMIC-S TECHNOLOGY

(Source: Belhaj, et al., 2015)




- GC-MS, LC-MS metabolomic profiling (Drupal et al., 2017): targeted and untargeted metabolites

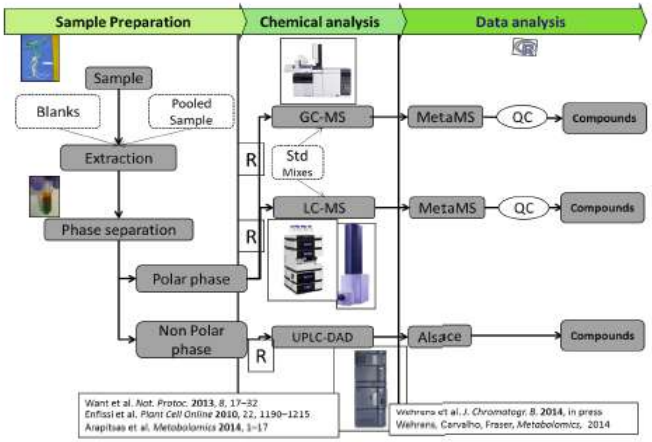



Figure 2. Displaying the workflow implemented for the analysis of the Cassava metabolome.

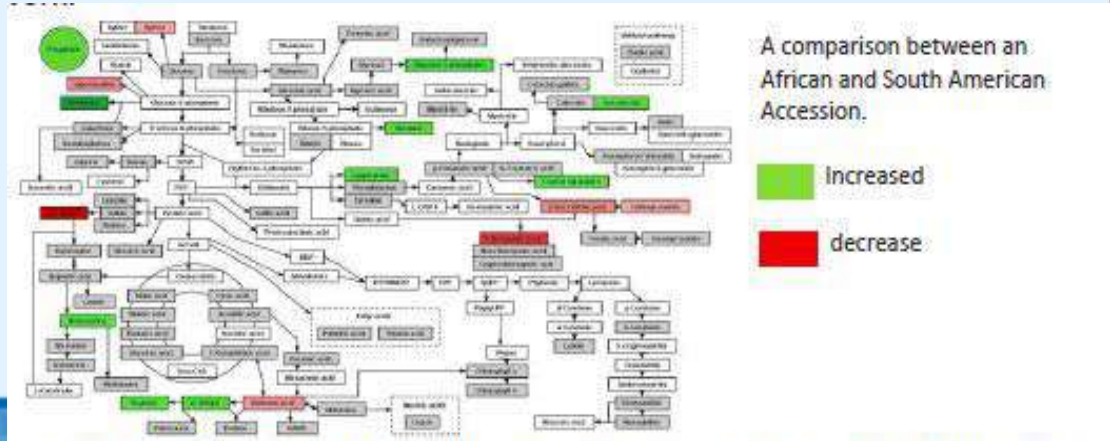



Figure 4. Biochemical network constructed from the metabolomics data.

# UTILIZATION OF COLLECTION

## BIODIVERSITY REFFERENCE COLLECTIONS

## at LIPI: highest number in Indonesia

**a. Museum Zoologicum Bogoriense (1819):**

**10th in the world : 3,035,609 (new: 20,000/y)**

**b. Herbarium Bogoriense (1841):**

**3rd in the world: >923,660 (5,000/y)**

**c. Indonesian Culture Collection – InaCC (2014): Collaboration Indonesia – Japan: SATREPS:**

Utilizing the microorganism that underpin rich tropical ecosystems in a diversity of industries

## The Potential Biomass in Indonesia

| Biomass | Place | 生産量 [million t/year] | エネルギー容量 [million GJ/year] |
|---|---|---|---|
| Rubber wood (ゴムの木) | Sumatera, Kalimantan, Java | 41 (5年間隔で置換) | 120 |
| Logging residues (伐木) | Sumatera, Kalimantan | 4.5 | 19 |
| Sawn timber residues (製材残基) | Sumatera, Kalimantan | 1.3 | 13 |
| Plywood and veneer production residues (合板残材) | Kalimantan, Sumatera, Java, Irian Jaya, Maluku | 1.5 | 16 |
| Sugar residues (サトウキビ残渣) | Java, Sumatera, South Kalimantan | Bagasse (バガス): 10<br>Cane tops: 4<br>Cane leaves: 9.6 | 78 |
| Rice residues (稲わら残渣) | Java, Sumatera, Sulawesi, Kalimantan, Bali/Nusa Tenggara | Husk: 12<br>Bran 2.5<br>Stalk: 2<br>Straw: 49 | 150 |
| Coconut residues (ココナッツ残差) | Sumatera, Java, Sulawesi | Shell: 0.4<br>Husk: 0.7 | 7 |
| Palm oil residues (パームオイル残差) | Sumatera new areas: Kalimantan, Sulawesi, Maluku, Nusa Tenggara, Irian Jaya | Empty fruit bunch (EFB): 3.4<br>Fibres: 3.6<br>Palm shells (PKC): 1.2 | 67 |

⇒ need to search microbial source and appropriate biomass






## POTENTIAL MICROBIAL RESOURCES

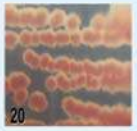
JST-JICA SATREPS PROJECT FY 2010-2015, LIPI and NBRC-NITE

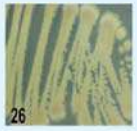
**International Standardized Microbial Resource Center to Promote Life Science Research and Biotechnology**

**Development of Indonesia Culture Collection (InaCC)**

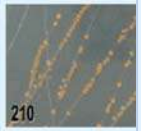
**Next step :**

**Development and Implementation of Indonesian Biodiversity-based Science & Technology**

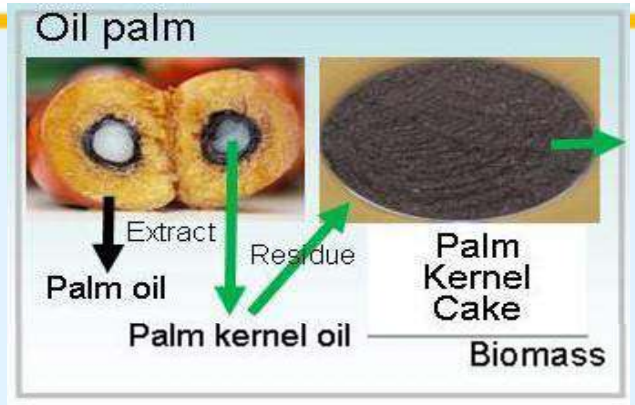


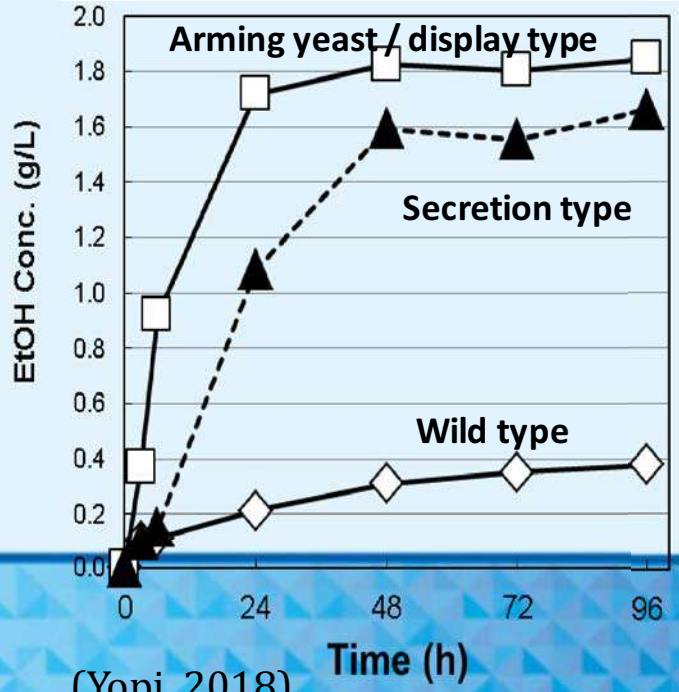




- **Combine the potency of biodiversity of cellulose biomass, microbes and its genetic sources**
- **Convertion of cellulose base biomass (waste) into valuable biofuels and bioproducts**
- **Sustainability and advanced technology**

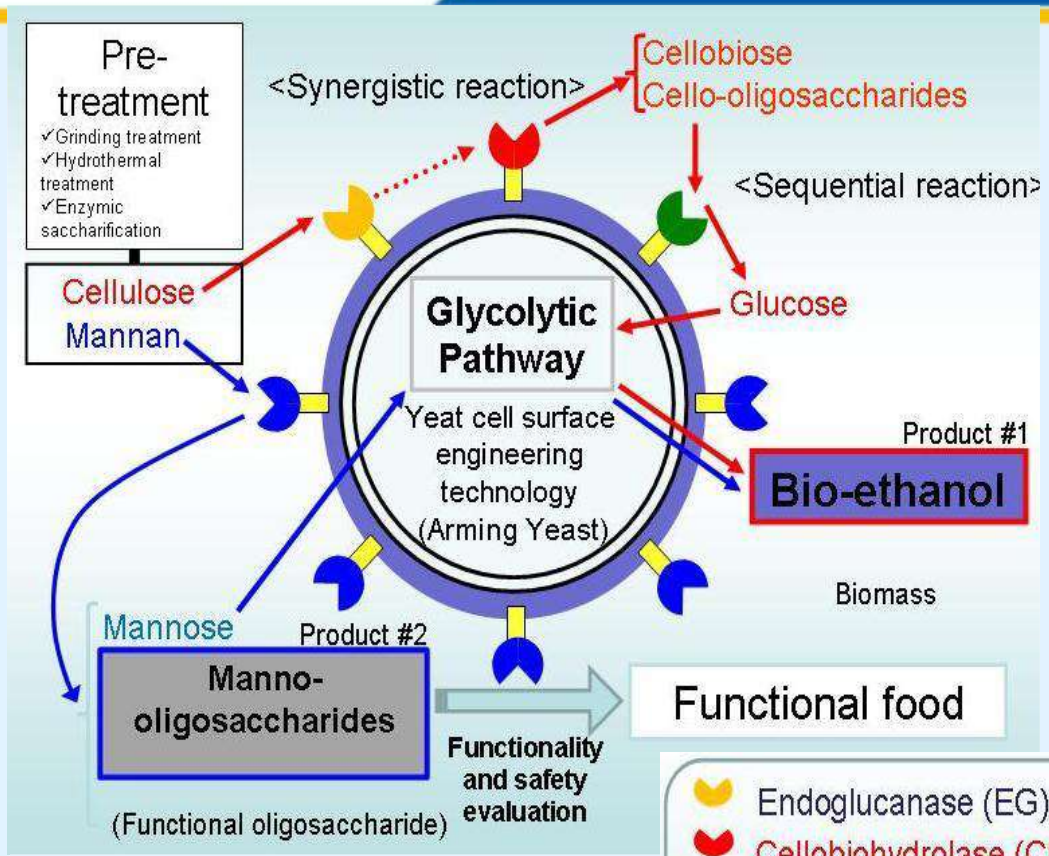
# JSPS-LIPI BILATERAL PROJECT FY 2011-2013

## Development of Consolidated Bio-Proccesing (CBP) for Bioethanol and Manno-Oligosaccharides Production by Yeast Cell Surface Engineering



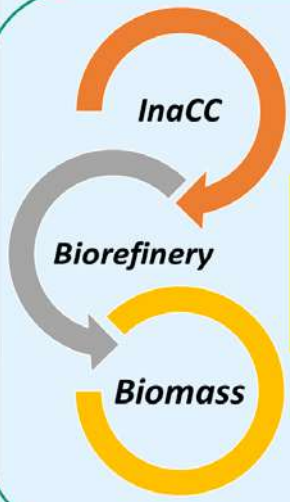




(Yopi, 2018)




**Recombinant Yeast Displaying Mannanase First report in the world**

# Research Supported by JST-JICA SATREPS Programmes → related to Bioeconomy




- ***Satreps I** : Development of Internationally Standardized Microbial Resources Center As A Core of Biological Resources Center to Promote Life Science Research and Biotechnology (JFY2010-2015)*
- ***Satreps II** : Innovative Bio-Production in Indonesia (iBioI): Integrated Bio-Refinery Strategy to Promote Biomass Utilization using Super-microbes for Fuels and Chemicals Production (JFY 2013-2018)*
- ***Satreps III** : The Project for Revegetation of Alang-alang (Imperata Cylindrica) Field Combined with Sustainable Production and Utilization of Biomass for Food and Energy Solution (JFY 2015-2020)*

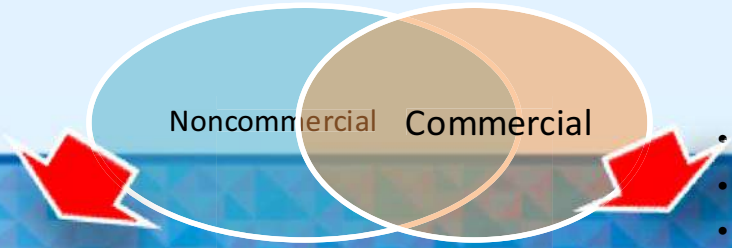

***Collaboration Scheme***

(Yopi, 2018)

# **SATREPS: 2011-2016:** Development of Internationally Standardized Microbial Resources Center to Promote Life Science Research and Biotechnology → establishment of **INDONESIAN CULTURE COLLECTION (Ina-CC )**

- Science and Technology Research Partnership for Sustainable Development (SATREPS): a joint project of JICA and the Japan Science and Technology Agency (JST): LIPI and NITE, University of Tokyo and RIKEN BioResource Center, enacted:
- (1) to establish a microbial resources center in LIPI,
- (2) to make the established center have functions for supporting the international transfer of microbial resources as a research base for microorganisms in Indonesia,
- (3) to introduce the diversity of microorganisms originating from Indonesia,
- (4) to promote the use of these microorganisms.

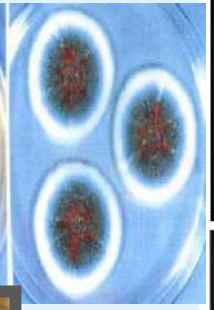
**Distribution and Use of Microorganism**




- Research and Education
- University
- Government office

- bioprospecting;
- Industrial use;
- Technology Development
- Public company

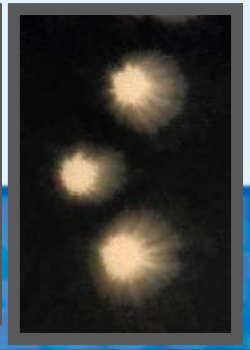
# INDONESIAN CULTURE COLLECTION (Ina-CC )= international standardized facility, national depository for living microorganisms → inaugurated in 2014

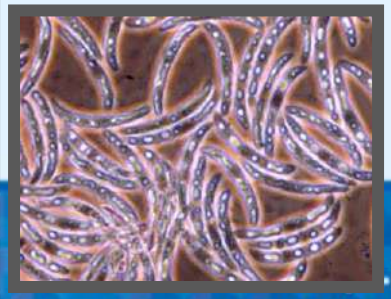




## Business Plan:

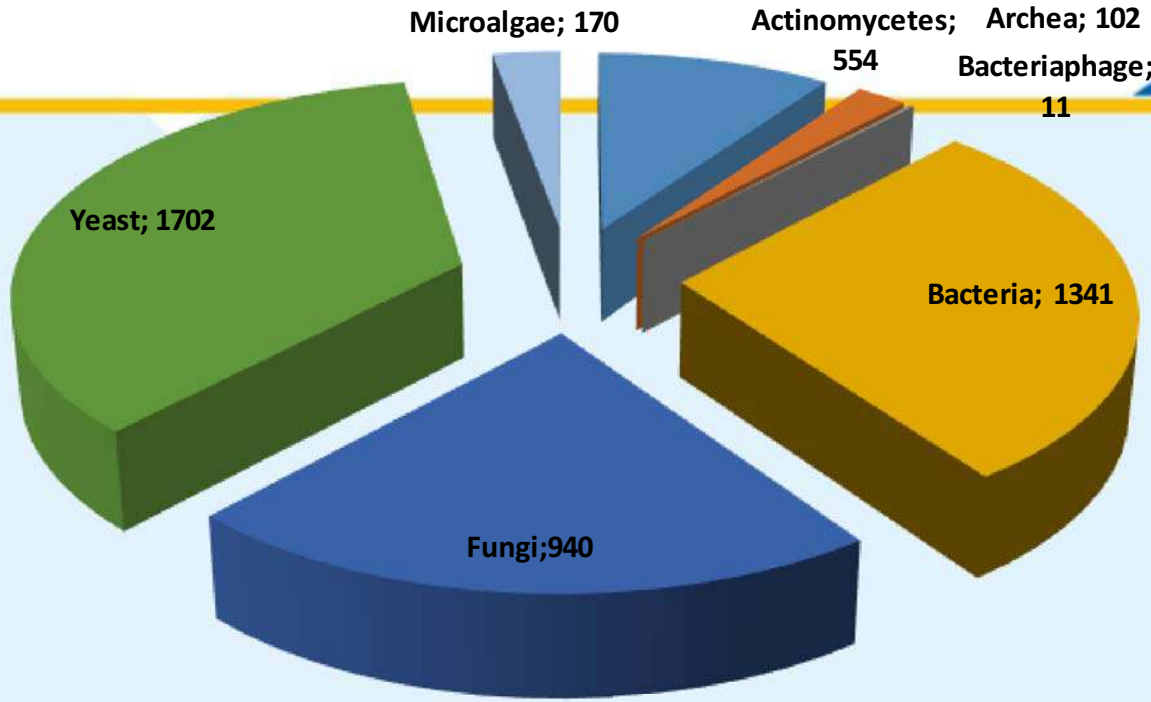
- Distribution
- Safety deposit
- Paten deposit
- Identification
- Analyses of Microorganisms
- Workshop, training





# InaCC: Depository and on line catalogue:

## http://inacc.biologi.lipi.go.id/




4820

- ✓ InaCC on line catalogue
- ✓ In House Database
- ✓ ASEAN Microbial Database (AmiBASE-Thailand)
- ✓ WDCM Database

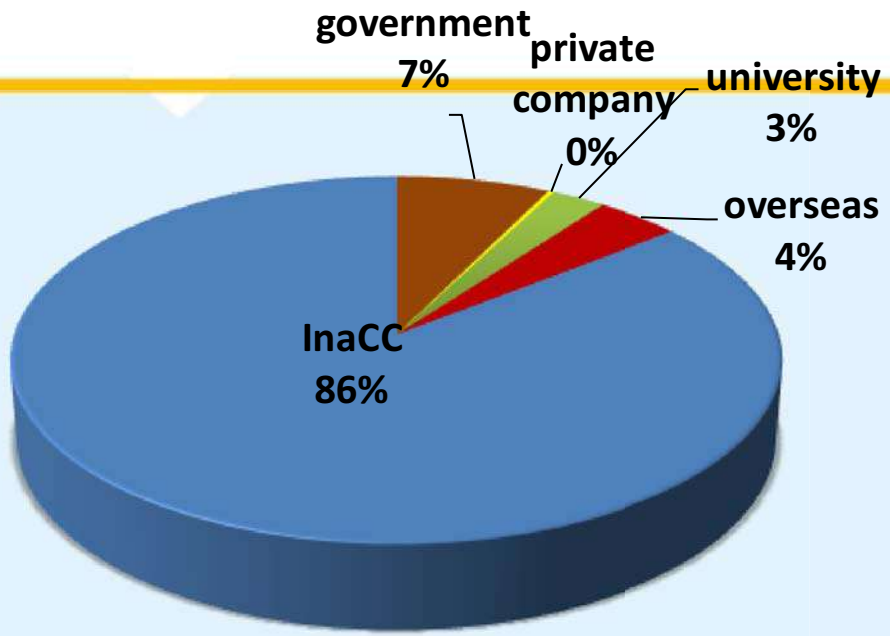
**Flow of management culture collection in InaCC:**

1. **Accept of deposit**
2. **Preserve the material**
3. **Quality control**
4. **Distribution**

10.000 Research and Development Collection

(InaCC, 2020)

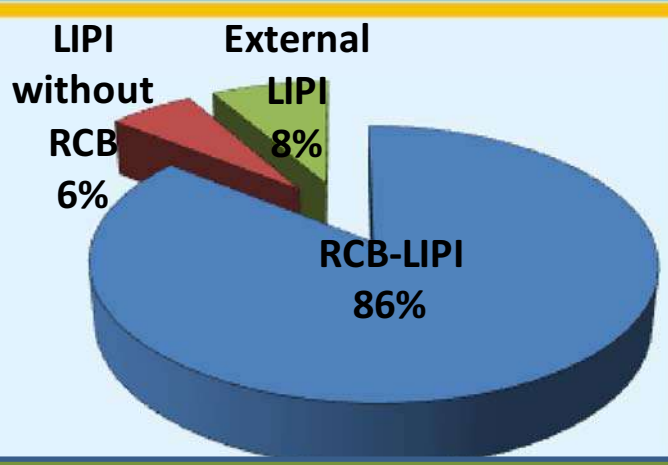
# Deposit by Type of Clients




| RCB (InaCC) | 4109 |
|---|---|
| Government | 384 |
| Overseas | 193 |
| University | 122 |
| Private company | 12 |

(InaCC, 2020)

## Source of Microorganisms



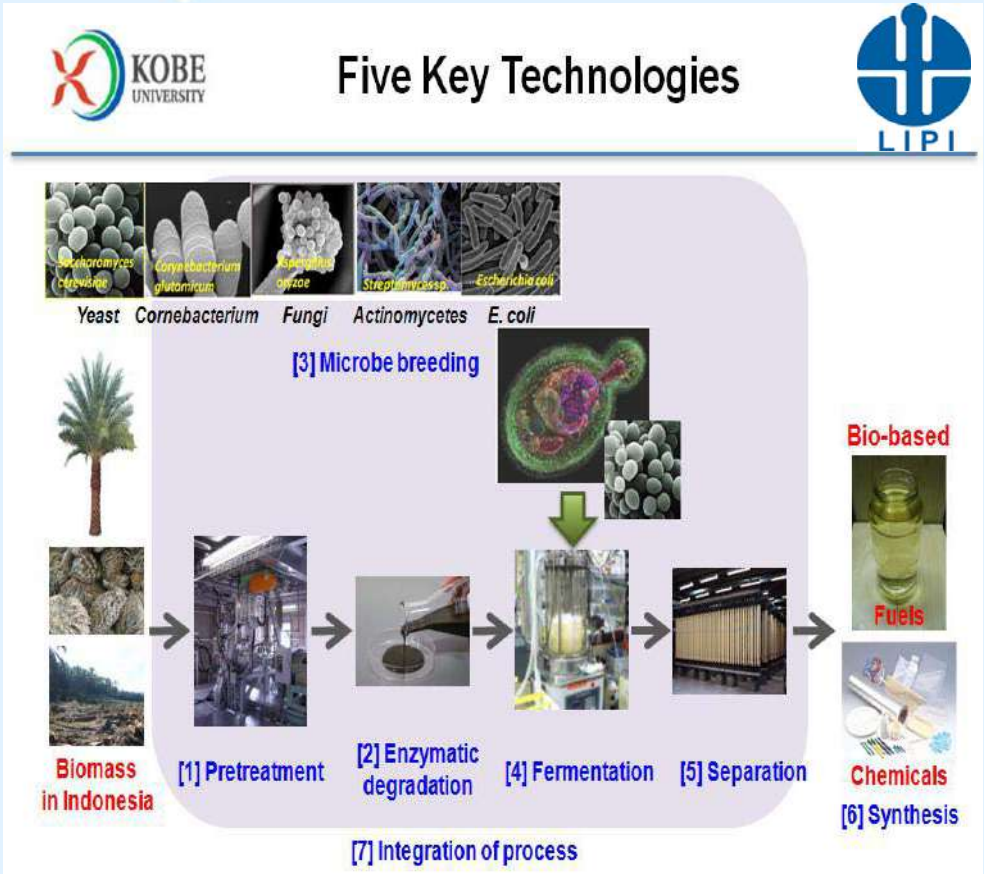

- Research Center for Biology (RCB)
- LIPI without RCB : Research Center for Biotechnology, Research Center for Chemistry, Research Center for Geotechnology
- External LIPI:

* Private sectors: PT. Petrokimia Kayaku (Biopesticide Company);
PT Central Proteinaprima (Shrimp producer & processor Company);
PT. Great Giant Pineapple (Plantation & canned pineapple Company) ;
PT. SMART Tbk

- Universities (National): Bogor Agricultural University, University of Indonesia, Riau University
- International: KCTC-KRIBB (Korea), Soka University (Japan), Wageningen University (Netherlands),

# SATREPS: Innovative Bio-Production Indonesia (iBioI) : Integrated Bio-Refinery Strategy to Promote Biomass Utilization using Super-microbes for Fuels and Chemicals Production FY 2013-2018

**PURPOSE OF THE PROJECT : ESTABLISHMENT OF *BIO-REFINERY RESEARCH CENTER IN INDONESIA*, ESPECIALLY FOR UTILIZATION OF LIGNOCELLULOSE BIOMASS TO PRODUCE BIO-FUELS AND BIO-CHEMICALS PRODUCT USING *SUPER-MICROBES***




**Main activities:**

[1] Establishment of pretreatment protocol

[2] Screening of degradation enzymes for ligno-cellulosic degradation

[3] Microbe breeding for chemical and fuel fermentation & Establishment of efficient separation technology

[4] Challenging of chemical synthesis of bio-based polymer from separated chemicals

[5] Feasibility study of integrated process &Promotion of bio-refinery platform into industry etc.

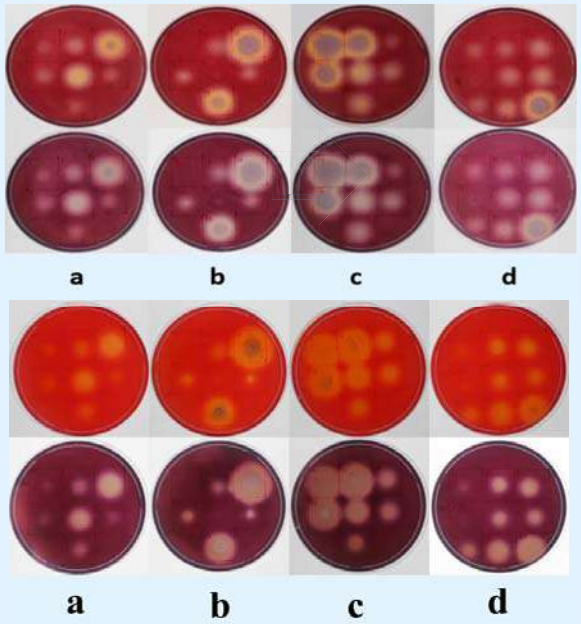
**Side result: Research Center for Biotechnology LIPI was designated as *Center for Excellence on Integrated Biorefinery in Indonesia* by Ministry of Research, Technology and Higher Education**

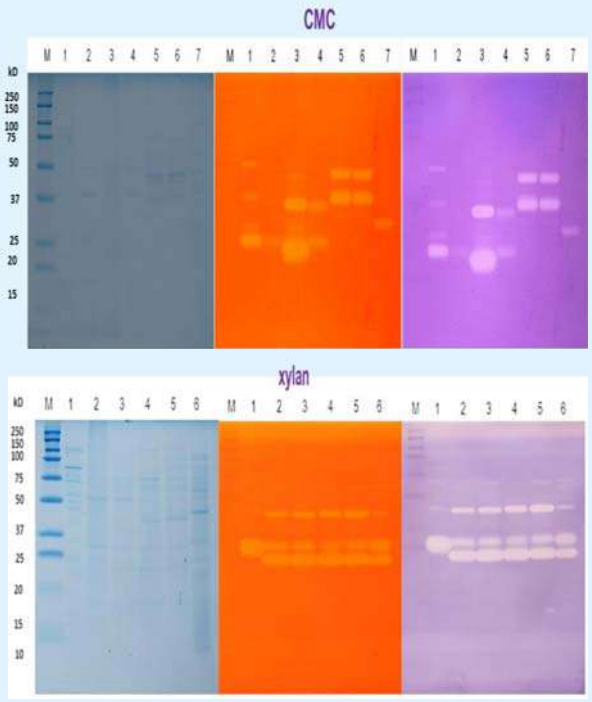
(Yopi, 2018)

# UPDATED RESULTS: SATREPS BIOREFINERY

## Main Research Activity :
## Biocatalyst Producing Bacteria and Sistem Production belong to Indonesia Culture Collection (InaCC)

Screening of 797 isolates (terestrial and marine microbes)




Current Project

- Already cloned 6 genes related for hydrolysis raw cellulose biomass
- Obtained the candidate for Production System (Actinomycetes)

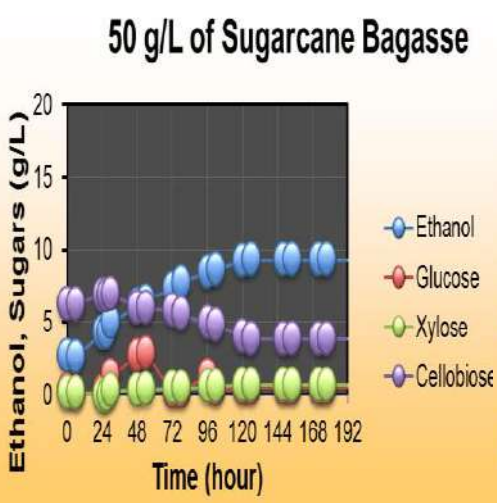
(Yopi, 2018)

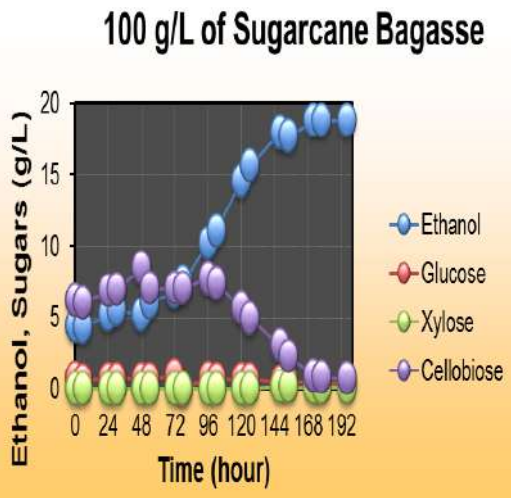
# UPDATED RESULTS: SATREPS BIOREFINERY

## *Isolate Yeast (BTCC-3) for bioethanol production using Bioreactor scale*

**Fermentation of pretreated bagasse in bioreactor 2L scale**

- **Biomass: pretreated bagasse 50 & 100 g/L**
- **Enzyme: cellulase & hemicellulase (Sigma) biomass**
- **Medium: 1.2L working culture-YNB medium in 2L fermentor scale**

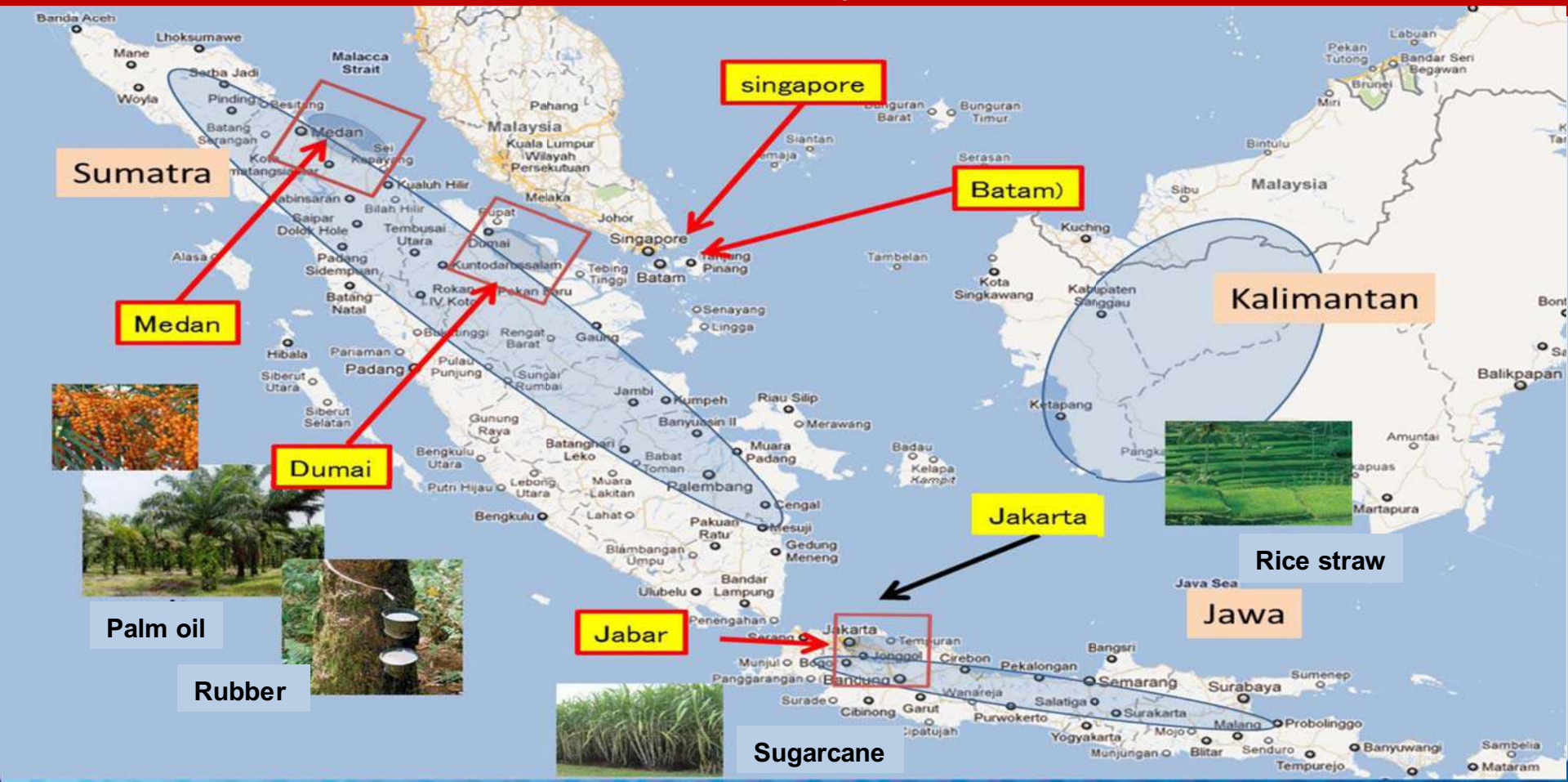






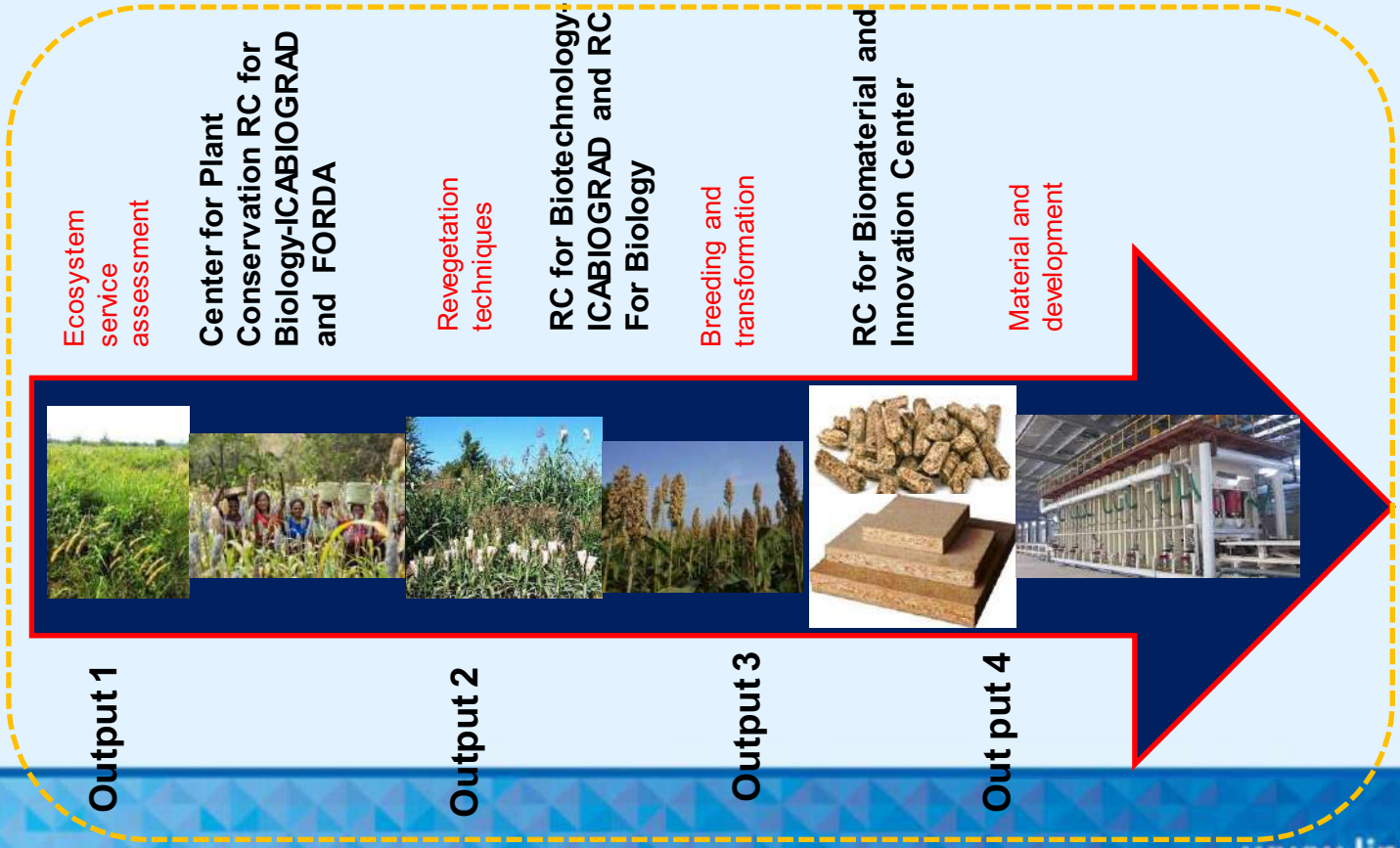
# *Implementation Target of Integrated Biorefinery in Indonesia : Biofuels & Bioproduct Suppply in Remoted Area/Island*




(Yopi, 2020)

- **SATREPS: 2016-2021: Producing Biomass Energy and Material through Revegetation of Alang-alang Fields:**
- Aims: 1) Production of bioenergy using biomass especially lignocellulosic materials; 2) Production of superior varieties resistant or tolerant drought and suitable for subotimal land based on selection and Molecular biology approaches for potential food, feed and bioenergy

## Project Output, RD Distribution under Low Carbon Society Principle

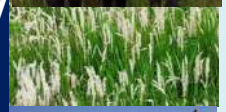



(Sudiana & Umezawa, 2018)

## Output 1 & 2

**Understanding the ecology of grass land and Developing methods for vegetative restoration of grass land**

**Center for Plant Conservation**
**Research Center for Biology**
**RC for Biotechnology, FORDA**

## Output 3

**Grass biomass plants with higher-heating value are obtained by breeding**

**Local Sorghum selection (lignin content, biomass, less nutrient input, drought tolerance)**

**RC for Biotechnology, and RC for Biology-LIPI, ICABIOGRAD**

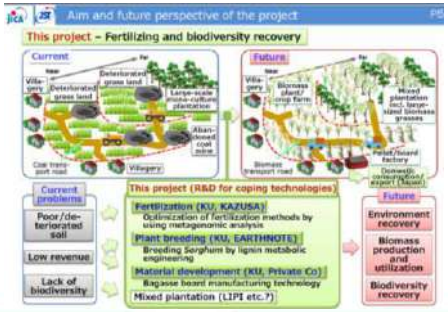


**Manufacture technology of environmentally friendly wood-based materials using gramineous plants is established**

Research Center for Biomaterial and Innovation Center-LIPI


## Out put 4

(Sudiana & Umezawa, 2018)




LIPI

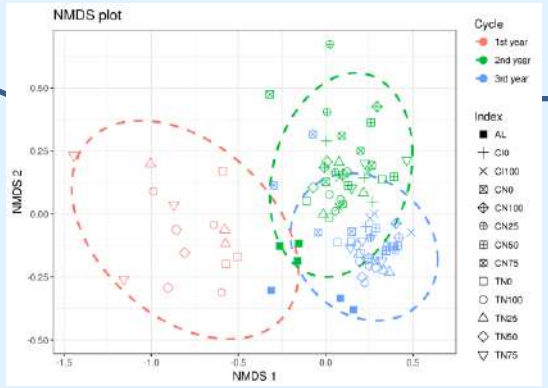
JICA JST

Metagenomic analyses for assessing the effect of fertilizer is established

Revegetation Technology for marginal land (alang-alang) is established

Candidate for Sorghum with a high lignin content is available

Biopellet and particle board production technology from sorghum biomass is established

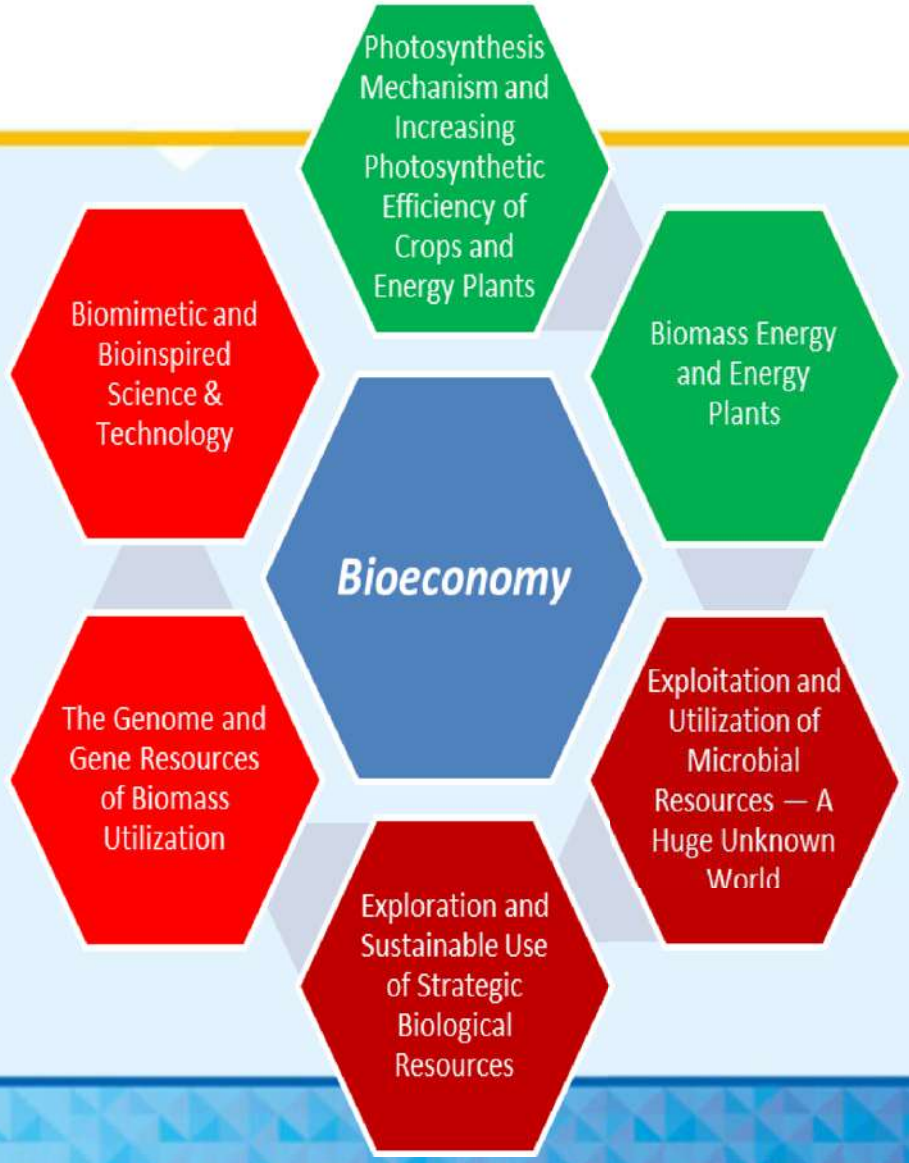



LCA and Techno-economy analyses is being performed

# PROJECT FOR PRODUCING BIOMASS ENERGY AND MATERIAL THROUGH REVEGETATION OF ALANG-ALANG FIELD

(Sudiana & Umezawa, 2018)

# Bioeconomy based on Science & Technology Biomass Resources




(Yopi, 2018)

- Within LIPI's Life Sciences Research Centres and InaCC collaboration → still require other partners especially industries:
- Advanced technology : biotechnology approach: for application of technology efficiency process for commercialization: Development of Cell-factory (super-microbes) based on local bioresources is crucial: JST-JICA Satreps Project Integrated Biorefinery resulted in:

a. the production of local super microbes could produce lactic acid up to 70 gram/Liter → to produce bioplastic and others;

b. engineered microbes able to produce biocatalyst involve in the production of biofuels from local biomass. Biocatalyst products are almost 95% imported. Local microbes and biocatalyst could support local demand → for significant bioeconomy, require industries and innovation.

- For Indonesia, require a more solid plan and targets for 2020-2040: bioeconomy based on local bioresources and technology innovation of Indonesian researchers.

# Technology Licencing on development of microbes based products

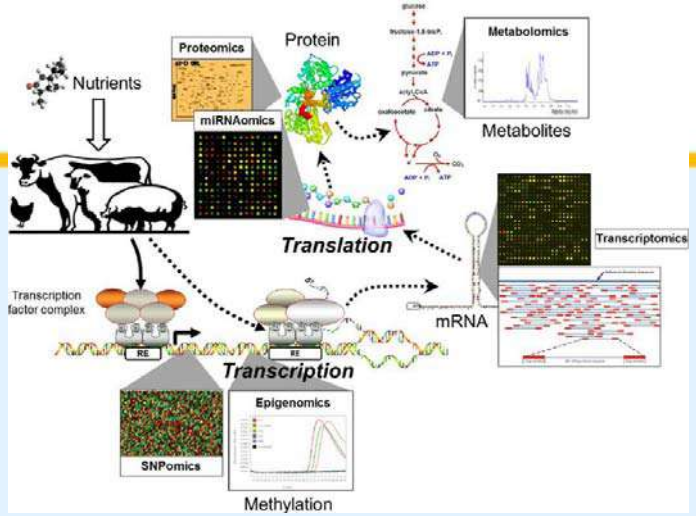

Collaboration with PT. Kalbe Farma



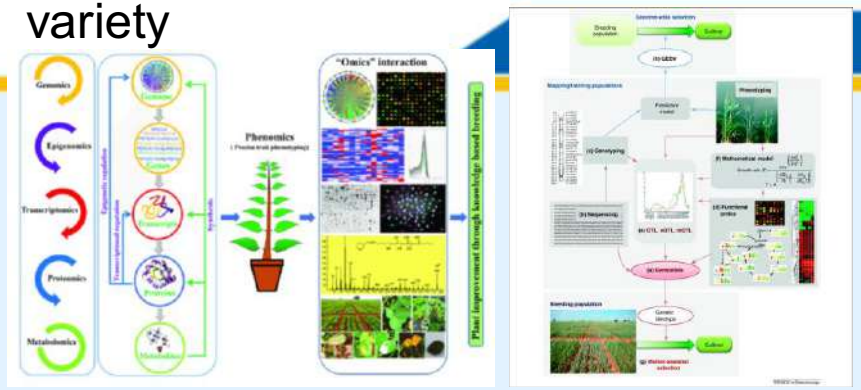
## Hand over research results to industries: to PT. BIOFARMA: Research Cell Bank (RCB) hEPO


# Application of Nutrigenomic + other –omics: improved feed formulation in line with age and growth phase lainnya

Reference: Loor et al., 2015. *J. Animal Sci. 93 (12).*



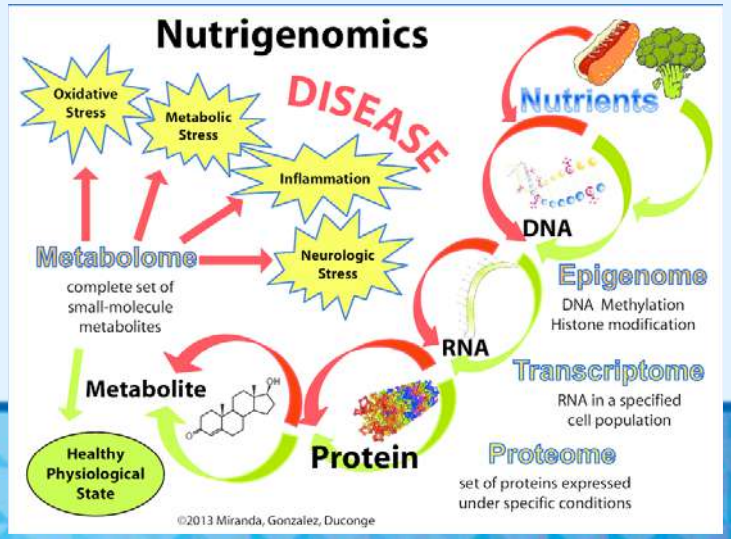

## Application of –Omics: for establishing plant improved variety

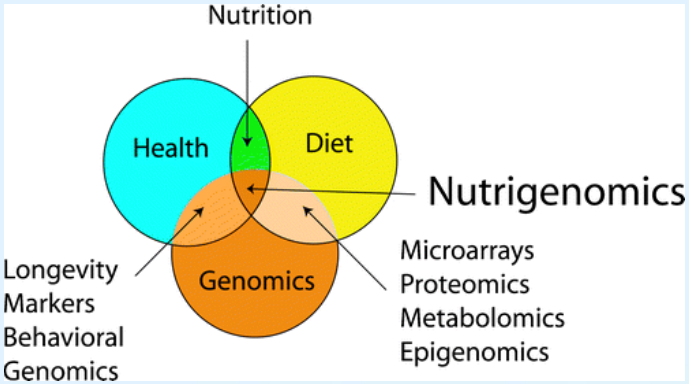


Reference: Kumar et al., 2018. Frontiers in Plant Science.
Langridge & Fleury, 2011. Trends in Biotechnology. Vol. 29, No. 1

## APPLICATION OF NUTRIGENOMIC FOR CURING DISEASE

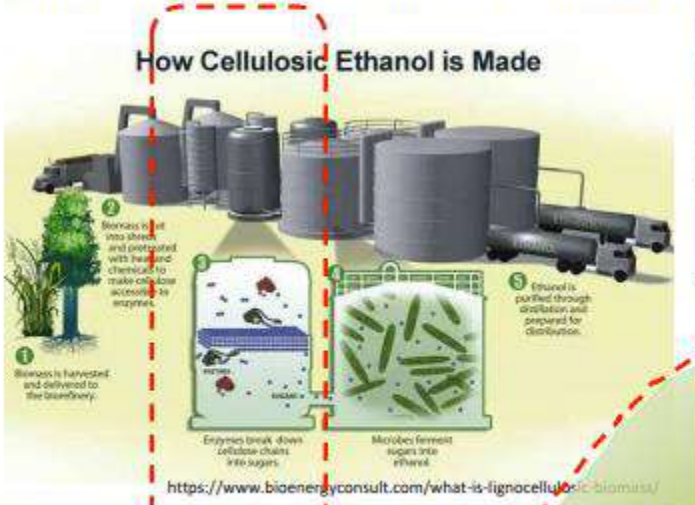
Gonzalez et al., 2015. Journal of Restorative Medicine, 4

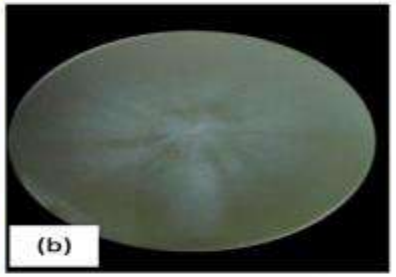


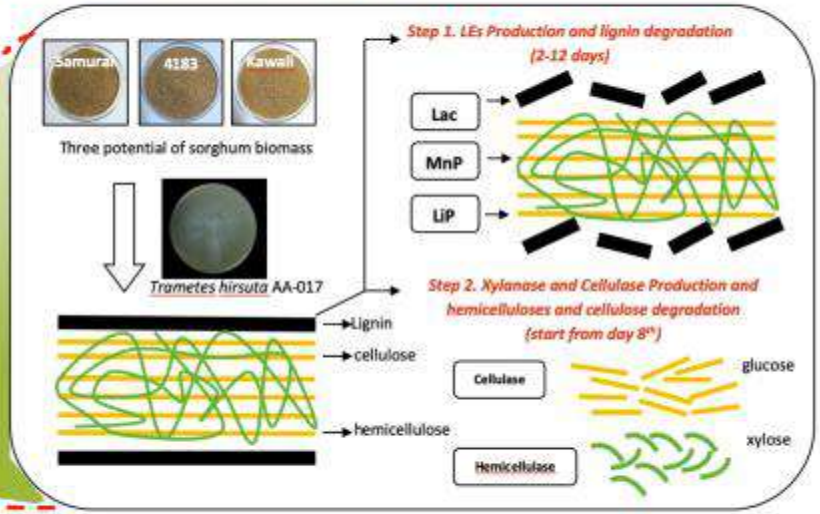



# Mycelia for Sustainable Biofuels

## HARNESSING FUNGI TO MAKE SUSTAINABLE BIOFUELS OF THE FUTURE



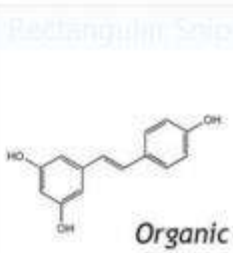



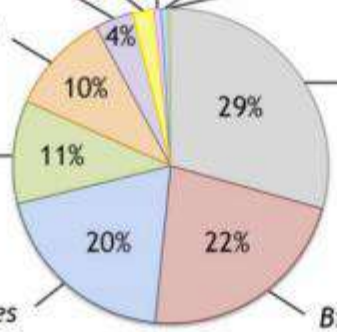




Andriani, et al. Bioresour. Tech. Rep. 2020.

# Laccase for green industry

**Bioremediation,**
**Food Industry,** Synthetic chemicals, **Pulp & Paper,** Grafting reactions, **Biorefinery,** Cosmetics, Personal care, **Pharmaceuticals**



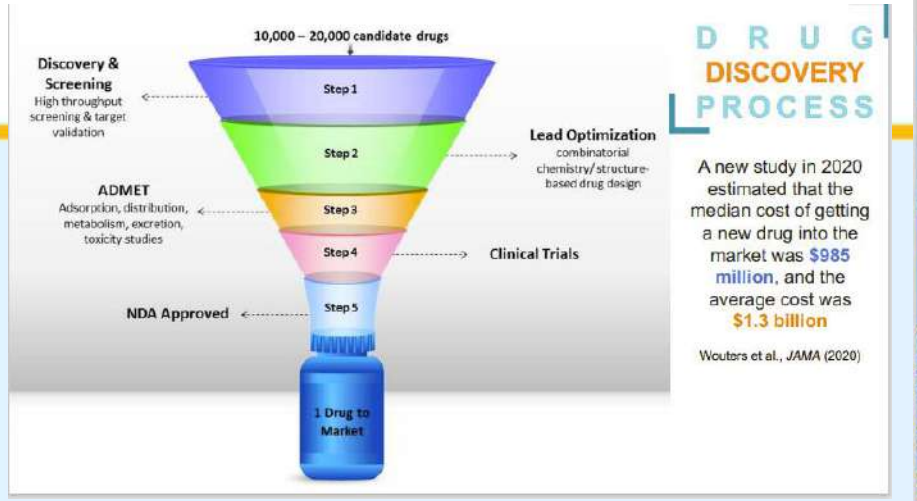



Mate & Alcalde, 2016

## Commercial laccase

| Laccase source | Company | Specific activity (U mg $^{-1}$) | Unit definition |
|---|---|---|---|
| *Agaricus bisporus* | ASA Spezialenzyme GmbH | > 5 | Conversion of 1 µmol catechol per minute at pH 6.0 and 25°C |
| Bacterial origin[a,b] | MetGen | 78 | Conversion of 1 µmol ABTS per minute at pH 3.0 and 60°C |
| *Cerrena unicolor* | Jena Bioscience | n.m. | Conversion of 1 µmol ABTS per minute at pH 4.5 and 25°C |
| *Trametes versicolor* | ASA Spezialenzyme GmbH | > 1 | Conversion of 1 µmol syringaldazine per minute at pH 5.0 and 25°C |
| *Trametes versicolor* | Sigma-Aldrich | ≥ 0.5 | Conversion of 1 µmol catechol per minute at pH 5.0 and 25°C |
| *Trametes versicolor*[c] | Sigma-Aldrich | ≥ 0.3 | Conversion of 1 µmol ABTS per minute at pH 4.5 and 25°C |
| *Agaricus bisporus* | Sigma-Aldrich | ≥ 4 | Conversion of 1 µmol catechol per minute at pH 6.0 and 25°C |
| *Aspergillus sp.* | Sigma-Aldrich | > $10^6$ | Conversion of 1 mmol of syringaldazine per minute at pH 7.5 and 30°C |
| *Rhus vernicifera* | Sigma-Aldrich | ≥ 50 | $\Delta A_{530}$ of 0.001 per minute at pH 6.5 at 30°C in a 3 ml reaction volume using syringaldazine |

# BIOPROSPECTING




## DRUG DISCOVERY PROCESS

A new study in 2020 estimated that the median cost of getting a new drug into the market was **$985 million**, and the average cost was **$1.3 billion**

Wouters et al., *JAMA* (2020)

## Drug Discovery from Marine Natural Products (MNPs)

- Oceans, which cover more than 70% of Indonesian territory, represent a virtually untapped resource for the discovery of potential new drugs
- More than 100 marine compounds have been isolated from **Indonesian marine organisms**, such as *sponges*, *soft corals*, *tunicate*, *algae*, and reported in more than 70 publications
- Marine organisms such as bacteria, fungi, micro- and macro-algae, cyanobacteria, and marine invertebrates produce substances with a wide range of **biological activities,** e.g. anti-cancer, anti-bacteria, anti-viral

## Marine Drugs

### FDA and EMA approved marine drugs

Each class of marine bioproducts has a potential multibillion dollar market value, e.g. **cytarabine** and **vidarabine** were estimated at **$93 million** each in 2007.

| Clinical status | Compound | Marine organism | Therapeutic area |
|---|---|---|---|
| FDA-approved | Brentuximabvedotin | Mollusk/Cyanobacterium | Cancer |
| | Cytarabine (Ara-C) | Sponge *Tethya crypta* | Cancer |
| | Omega-3-acid ethy estrers | Fish | Hypertiglyceridemia |
| | Ziconotide | Cone snail | Pain |
| | Eribulin Mesylate | Sponge *Halicondria okadai* | Cancer |
| | Vidarabine | Sponge *Tethya crypta* | Antiviral |
| EMA-approved | Trabectedin | Tunicate *Ecteinascidia turbinata* | Cancer |

Putra and Murniasih, J. Coast. Life Med. (2016)

## Prialt®

One of successful pharmaceutical products from Indonesia approved by FDA is **peptide ω-conotoxin MVIIa** (Prialt ® by Elan Pharmaceutical) from the venom of the cone snail *Conus magus*. Prialt is used for **analgesic treatment.** It has been reported that the revenue from the sales of Prialt reached **$6.1 million** in 2010

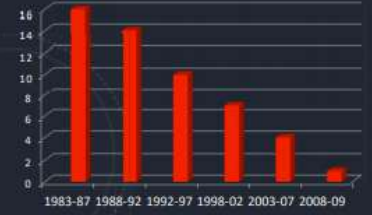
(Masteria, 2020)

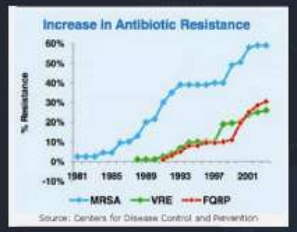
# BIOPROSPECTING

## The needs and challenges of new drug discovery

- Many drugs become less effective due to resistance problem
- R&D pipeline for new anti-infectives is drying up

Total antibacterials Approved in US since 1983




- Traditional approach to drug discovery is no longer sufficient to provide novel drugs
- The rate of discovery of new compounds has declined

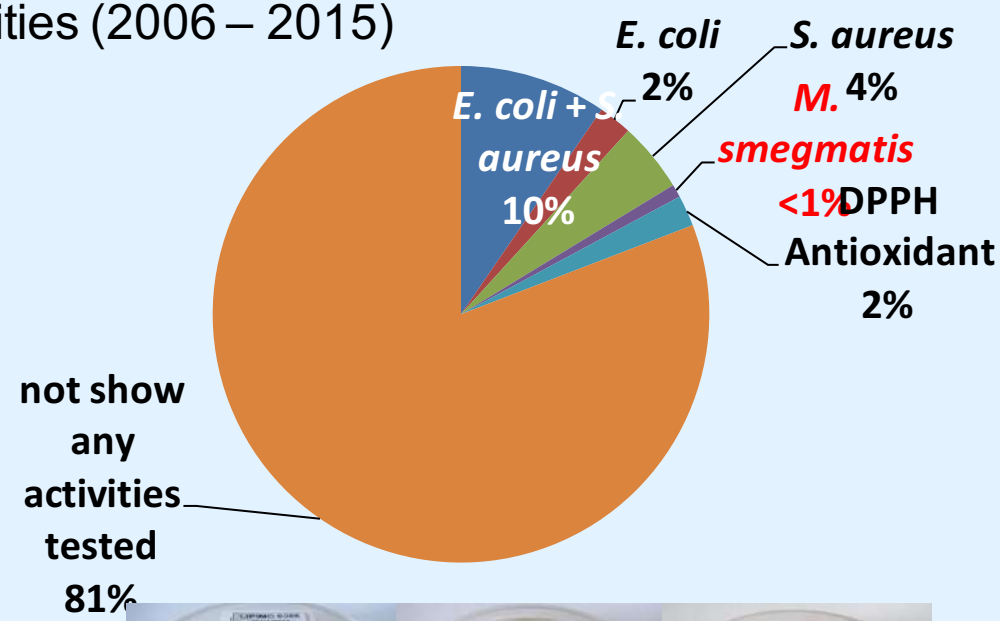

(Taifo 2020)

# JASTIP results: Discovery of (+)-2,2'-epicytoskyrin as an antibiotic candidate: oral toxicity test and inhibition of abcess formation (A. Agusta, P2 Biologi LIPI):

## Preliminari Screening for Antibiotic and Antioxidant Substance

Medicinal plant

More than 800 microbial isolates have been screened for their antimicrobial and antioxidant activities (2006 – 2015)




1. *Rennellia eliptica*
2. *Rennellia speciosa*
3. *Uncaria gambier*
4. *Tinospora crispa*
5. *Archangelisia flava*
6. *Garcinia mangostana*
7. *Curcuma aeruginosa*
8. *Camellia cinensis*
9. *Cinnamomum burmannii*, etc.

**(Agusta, P2 Biologi LIPI;** andr002@lipi.go.id)

# *Food Supplement to prevent* Osteoporosis

(source: RC Chemistry LIPI)


Inulin from crysant tuber

crystal DFA III


## Commercial Product: Herbs based cream for skin:

Cream product

Gotu kola (*Centella asiatica*) leaves

ginger

Passed: clinical trial, incubator business stage

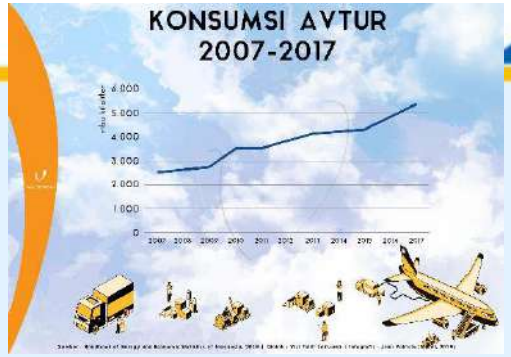
# Herbal tablet from breadfruit for Hipercolesterolemia, diabetic disease (source: RC Chemistry LIPI)

In collaboration with PT Kalbe Farma (CDA clinical trial) and PT Nurshiha (large scale production)


## BIOENERGY: REQUEST by INDUSTRIES, e.g. PERTAMINA (Indonesia semi state company)

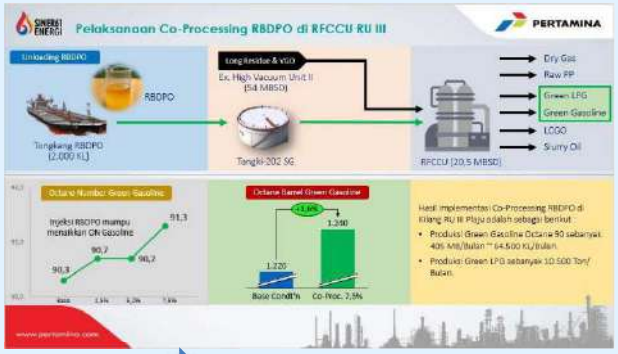
- B30→ blending CPO
- Biodiesel from CPO
- Convertion from Biomass (oil palm etc) through pyrolisis→ syngas
- Bioethanol
- Algae for Biooil

# Palm Oil Based Fuel: Bioavtur

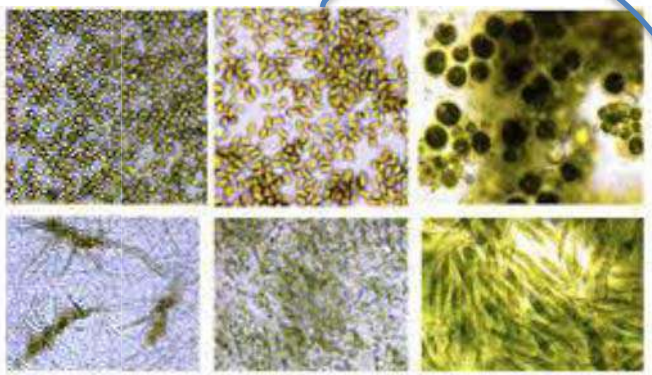






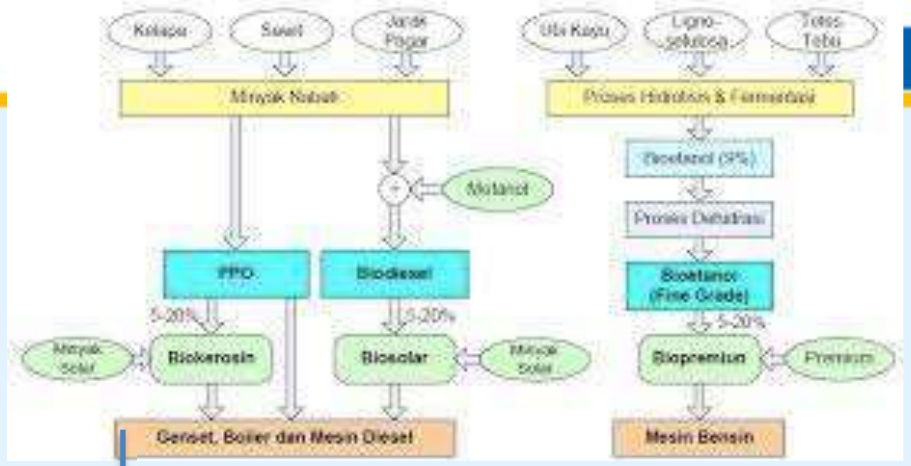

Process of CPO to Bioavtur

# Microalgae Based Fuel → Biohydrogen



LIPI's collection, collected from Indonesia including from GSK-BR and Wakatobi Biosphere Reserves which belong to Chlorophyte, has potential use as biomass source for biodiesel as they are lipid depositor.

Photobioreaktor Skala 1000 Liter




Scooter with biohydrogen fuel from microalgae → in collaboration with Feng Chia University (Taiwan): APEC-ACABT Programme


(RC Biotechnology LIPI, 2019)

United Nations
Educational, Scientific and
Cultural Organization

# The MAB Programme: Biosphere Reserves (714 in 129 countries) offer ecosystem services to support bioeconomy, in addition to products

## The 3 Functions of Biosphere Reserves are pursued through their 3 zones

**Conservation of biodiversity and cultural diversity**

**Economic development in a socio-culturally and environmentally sustainable**

**“Logistic” support, underpinning development through research and training**

# Bioeconomy: product and services in Biosphere Reserves designated by UNESCO: Cat Ba BR (Vietnam) & Leuser BR (Indonesia): health related products and ecotourism

- Ecotourism: guides, local farmers (elephants food), mahouts, homestay owners, restaurants.
- Ecotourism + Komodo's **Immunity system: CAMPs (*Cationic Antimicrobial Peptides*): for antimicrobial therapy**
- **Products based biodiversity**

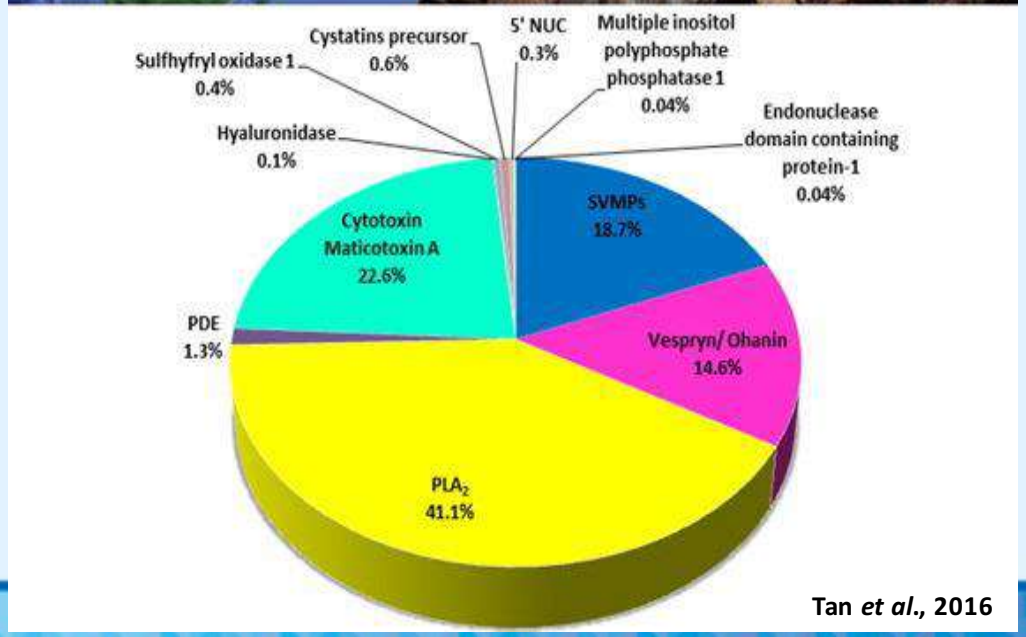






- **26 products and ecotourism services were certified in CatBa BR (Vietnam)**

# Bioprospecting: a MoU between LIPI and PT. Biofarma: venom *Calliophis bivirgatus*:


Tan *et al*., 2016

**Area of Distribution: Malaysia, Indonesia (Sumatra, Jawa, Kalimantan)**

**Unique venom profile dominated by: phospholipase A2, Maticotoxin A, SVMPs, and Ohanin**

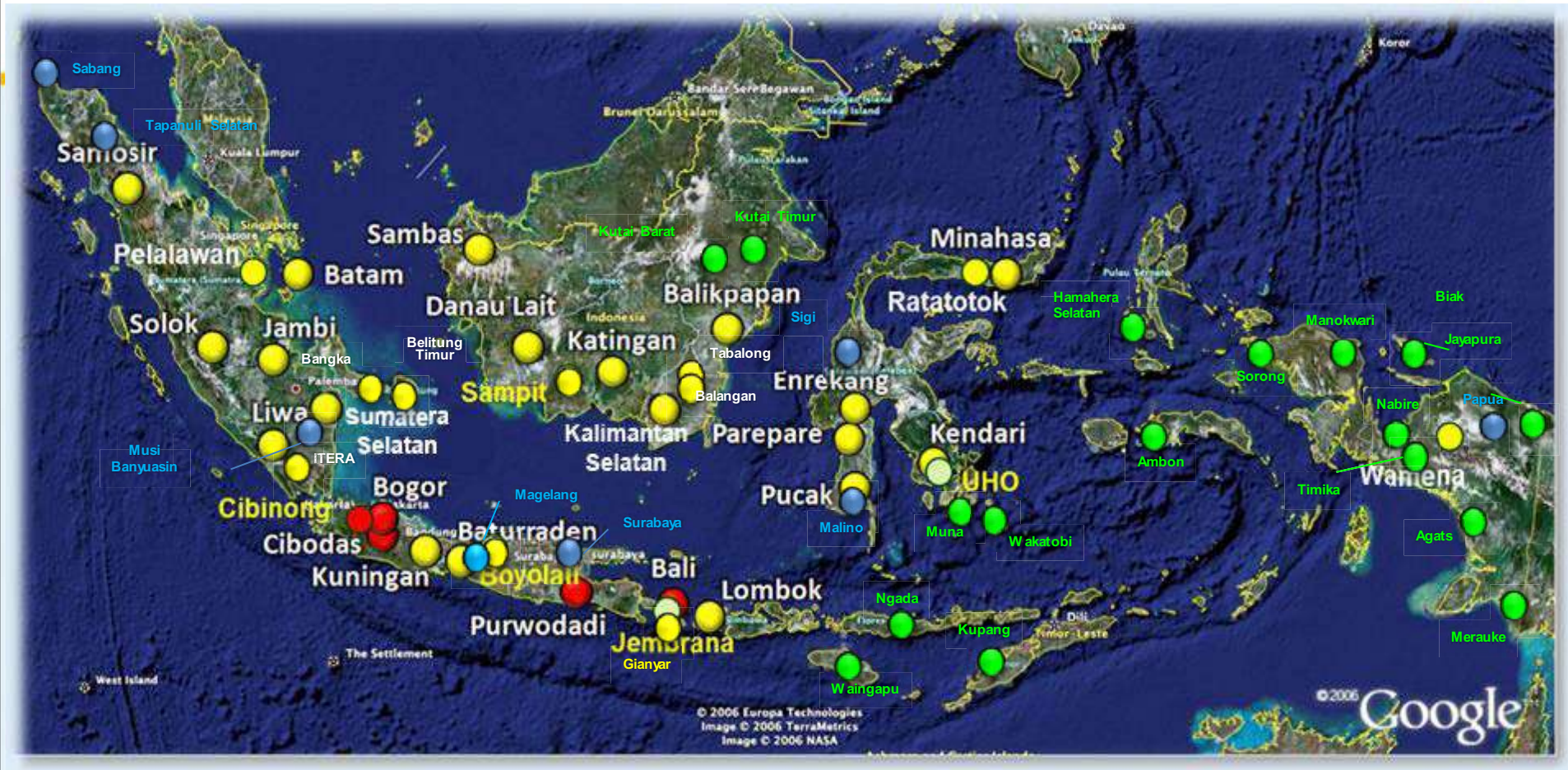
**Modification of venom (detoxify): painkillers, 20x more effective than morfin (with no side effect) in 2.000 x effective dosage.**

Tan *et al*., 2015; 2016

# INDONESIA's BOTANICAL GARDENS DEVELOPMENT UPTO 2030

**(GSPC Target 8:** Target 8: At least 75% of threatened plant species in *ex situ* collections, preferably in the country of origin, and at least 20 per cent available for recovery and restoration programmes.

LIPI




- 5 under LIPI
- 34 under Local Government: province, district, city, supervised by LIPI
- Initiated Botanical Gardens (BG) up to 2018/2019
- Targetted BG by 2030: total to represent 47 ecoregion, up to now: represented 17 ecoregions

# Bioprospecting in BOTANICAL GARDENS: example

**The oldest: Bogor BG: established in 1817**


Dede HYY, 2020

# 1. Collaborations: MoUs: National & International
# 2. Legal Aspect, Policy

DJKI
DIREKTORAT JENDERAL KEKAYAAN INTELEKTUAL
KEMENTERIAN HUKUM DAN HAK ASASI MANUSIA R.I.

TECHNO SURUGA LABORATORY, JAPAN

InaCC
Indonesian Culture Collection

鳥取大学
Tottori University

## Presidential Decree of Microorganism Resources Management

# Draft of Presidential Decree: Sustainable Microorganism Management: initiated in 2014

- **Protecting microorganism and their ecosystem**
- Standarization of microorganism management;
- Increasing the value microorganism for economic development
- **Promoting ABS**
- Provide legal formality on business on microorganism
- *Biosecurity*

- Multilateral treaty
- Signed in Earth Summit in Rio de Janeiro 5 Juni 1992
- Ratified by Govt of RI: Act 5/1994

25 YEARS Convention on Biological Diversity
SAFEGUARDING LIFE ON EARTH

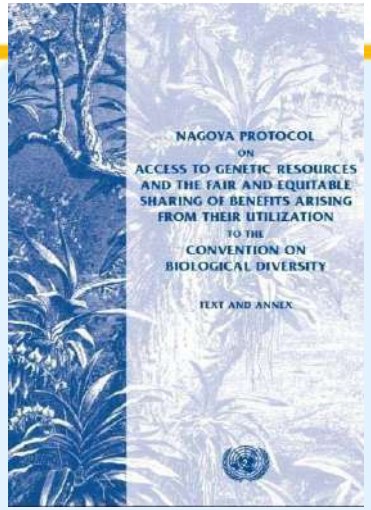
Conservation of Biological Diversity

Sustainable use of its component

fair and equitable sharing of benefits arising from genetic resources

# NAGOYA PROTOCOL

Act No. 11, Year 2013



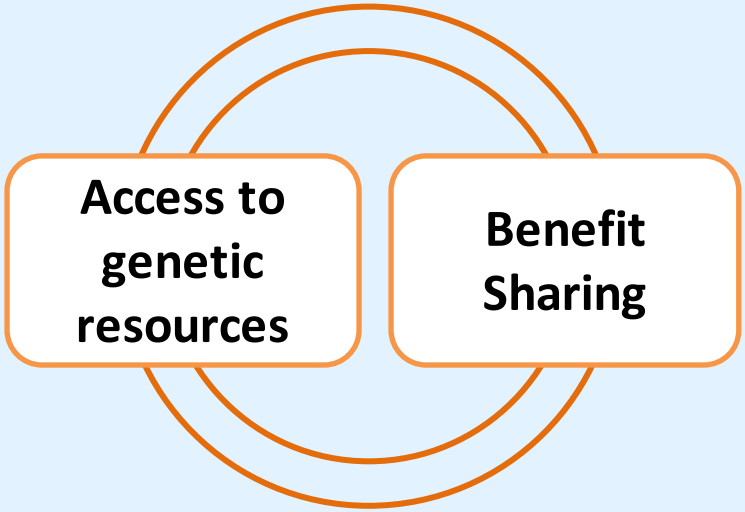

Purposes: benefit sharing: fair and equal from the use of genetic Resources, and related appropriate technology transfer, considering all Rights on resources and technology with adequate funding → contribute to Biodiversity conservation and sustainable use of its components

P.2/MENLHK/SETJEN/KUM.1/1/2018 (Indonesia's Mo Environment and Forestry Decree)

- Access
- Material Transfer
- Institutional
- Supervision and Control
- Sanction

# Principles of Access and Benefit Sharing

"Biodiversity rich" countries facilitate access to genetic resources



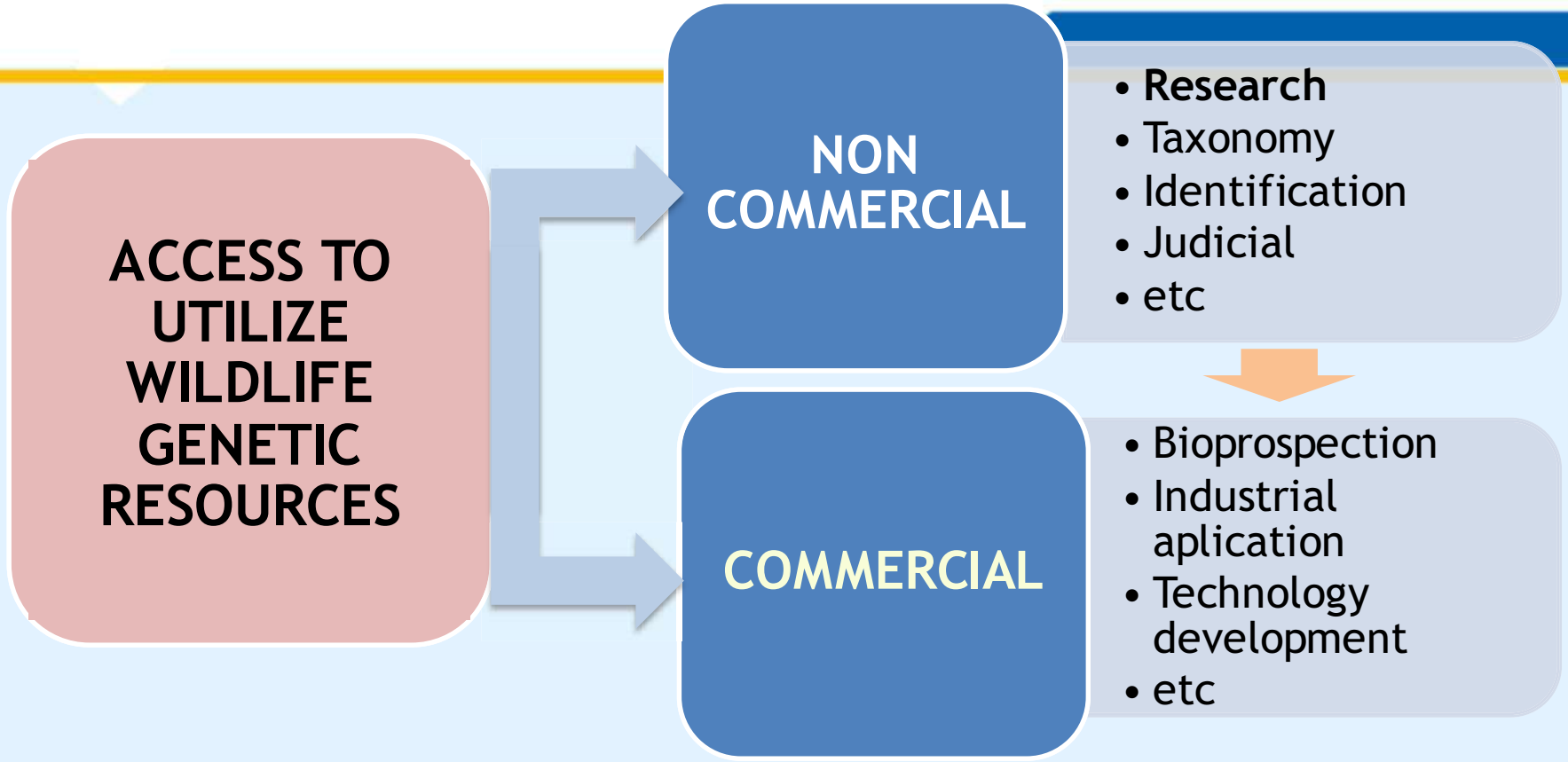

"Tecnology-rich" countries share benefits of using GR and facilitate access to technologies and knowledge relevant for the protection and sustanaible use for biodiversity

(Indonesia's Ministry of Environment and Forestry Decree, 2018)

**GENETIC RESOURCES**

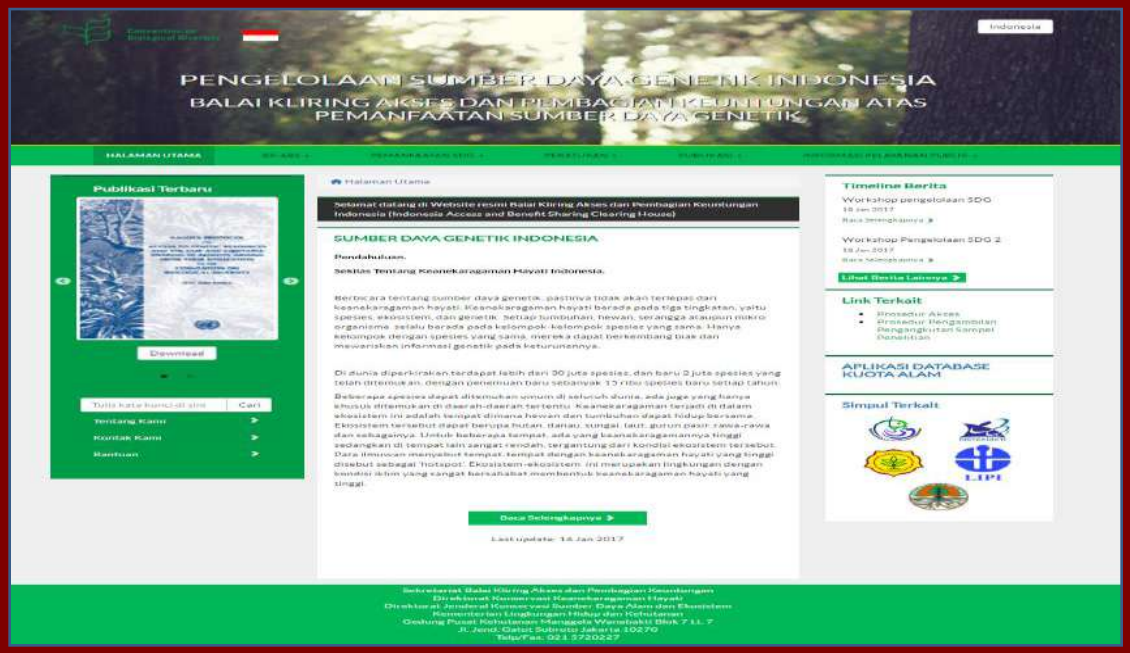
- **GENETIC MATERIAL OR ITS *DERIVATIVES + SYNTHETIC BIOLOGY***
- **GENETIC INFORMATION + DSI (DIGITAL SEQUENCING INFORMATION)**
- **TRADITIONAL KNOWLEDGE RELATED TO GENETIC RESOURCES**

(Indonesia's Ministry of Environment and Forestry Decree, 2018)




(Indonesia's Mo Environment and Forestry Decree, 2018)

# ABS Clearing House Mechanism




**Balai Kliring Akses dan Benefit Sharing SDG**
**http://abschindonesia.menlhk.go.id**

## Material Transfer Agreement (MTA)

LIPI
The Indonesian Institute of Sciences (LIPI)

**NON-COMMERCIAL**
**BIOLOGICAL MATERIAL TRANSFER AGREEMENT**
No. /LIPI/VII/2016

This Biological Material Transfer Agreement is made on this day, by and between:

Research Center for Biology – Indonesian Institute of Sciences, an Indonesian government institution existing under the laws of the Republic of Indonesia, having its registered office at Cibinong Science Center, Jalan Raya Bogor KM. 46, Cibinong, Bogor, West Java, Indonesia.
Dr. Ir. Witjaksono, M.Sc. as Head of Research Center for Biology – Indonesian Institute of Sciences, and (to be filled by name of scientist from RCB LIPI), domiciled at Research Center for Biology – Indonesian Institute of Sciences, Cibinong Science Center, Jalan Raya Bogor KM. 46, Cibinong, Bogor, West Java, Indonesia (hereinafter referred to as "PROVIDER")

WITH

Name of Partnering Institute (Abbrevation) which is existing under the laws of (name of partnering country), having its registered office at .....(Institution Partner's address).
Represented by (name of representative in charge), in this matter acting in his capacity as the Head/ Director/etc. (position), ..... (Abbreviated form of Partnering Inst.).

In Consideration of the RECIPIENT'S covenant and premises contained herein, the PROVIDER intent to transfer to the RECIPIENT materials as follows (number of sample, name, etc. with complete list attached):

for the sole purpose of the study and for specific assays as described in Research Plan/ Protocol (Appendix), which shall be an integral part of this agreement, upon the terms and conditions hereinafter appearing:

..... (Abbreviated form of Partnering Inst.) hereinafter jointly referred to as "RECIPIENT".

# PROBLEMS IN BIORESOURCES FOR SUSTAINABLE DEVELOPMENT

- Insufficient awareness
- Not integrated, short research period
- Lack of policy and political will
- Most ASEAN countries are still focusing on biobased energy
- Waste are abundant in many areas which have not been utilized
- Lacking of human resources: quantity and quality: for initiation and maintenance
- Interest of investors and private sectors on biobased industry development still low.

# WAY FORWARD AND CONCLUSIONS

- By mainstreaming bioresources, ASEAN would be a successful regional bioeconomy if supporting the growth of a nutraceuticals, health-related products, second generation-based industries which will be enhanced through partnerships between countries within ASEAN.
- Increasing awareness and capacity building on sustainable use of bioresources are of importance for biobased economy development.
- Industry, research institutes/universities and community have to be involved in bioresources-based research to ensure the commercialization and utilization of research results
- Science, research and technology and innovation to boost bioeconomy needs to be strengthened and to be implemented with the principle of zero waste, zero emissions, integrated approach.

**THANK YOU**